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**Utilizzo di una metodica innovativa e non invasiva per controllare la
sintomatologia infiammatoria durante il decorso postoperatorio in
interventi di implantologia**

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CONTROL OF POSTOPERATIVE DISCOMFORT BY LOCAL PHYSICAL THERAPY AFTER ORAL SURGERY

ABSTRACT

PURPOSE

Surgical treatment in implantology and dental surgery is a common procedure that often accompanied by pain, swelling and trismus.

Many patients in their postoperative complain situations of discomfort and reduced quality of life.

The aim of the present study was to investigate how control postoperative morbidities, whether the local application of elastic therapeutic tape (KT).

MATERIALS AND METHODS

To address the research purpose, the investigators designed and implemented a multicentric study with parallel-group. Patients were prospectively assigned for treatment of unilateral and bilateral implant placement and allocated to receive treatment with or without KT application according to joint patient and clinical decision.

KT was applied directly by the same Physical Therapist after surgery and maintained for 3 days postoperatively. Facial swelling was quantified using the Laskin Method to measure inflammation, through three measurements pre surgery, post surgery after 24 hours, and 48 hours (DHS, DHC, DV, WHI). Pain score was assessed using a 0-10 level Visual Analog Scale, and pain drawing.

Mouth opening was measured, with the Laskin method using a millimeter ruler.

In addition, all patients were asked to evaluate overall satisfaction and swelling and the effect of the tape on movement and comfort after KT application, between a quality of life scale evaluation.

Inclusion criteria were: unilateral elevation of maxillary sinus, multiple implant placement, simple tooth extractions, unilateral or bilateral impacted upper and lower third molars extraction.

Exclusion criteria were: patients younger than 18 years, pregnant or lactating women, sensitivities to tape, unwillingness to shave facial hair, known allergies to medication used in the study. Patients developing unforeseen inflammatory reactions after surgery.

RESULTS

50 patients were investigated but only 30 patients were included in the study respected on inclusion criteria (17 female and 13 male; mean age KT, 57.7 yr; standard deviation KT, 12.4 yr; mean age no KT, 56.7 yr; standard deviation no KT, 12.1 yr). Application of KT after surgery for implantology had a statistically significant influence on tissue reaction and swelling, decreasing the incidence of swelling and turgidity by more than 30% in the first 2-3 days post surgery. Although KT had significant influence on reducing pain control, patients perceived significantly lower morbidity.

CONCLUSION

The present results showed that the application of KT after implantology surgery is a promising, simple, a-traumatic, and economical approach for managing postoperative swelling and pain that is free from systemic adverse reactions, for improving quality of life of our patients.

Keywords: Kinesio tape, implantology, dental surgery, pain, swelling, morbidity

INTRODUCTION

Implant treatment is currently the best therapy for the rehabilitation of edentulous patients, as an alternative to traditional prosthesis, with an overall success rate equal to 95-98% (Berglundh, T. et Al., Papaspyridakos, P. et Al., Pjetursson, B. E. et Al.). In the late few years a number of techniques and protocols were proposed by many authors in order to expand the field of application of implant treatment to different types of edentulism.

However, a major drawback of the surgical procedures for implant placement is that they are often associated to pain, trismus, swelling, and postoperative morbidity that negatively affect a patient's quality of life (M. Goldaman, et Al., Schmidt-Hoberg W. Et Al., Luhr Hg, et Al., Jemt T.).

Several types and intensity of tissue reactions are thought to arise from an inflammatory response as a direct and immediate consequence of tissue trauma from the surgical procedure.⁶ Furthermore, several types of complications, such as hemorrhage or sepsis, may occur (Oliver Ristow MD., 2013, Satomi K, et Al., Schmidt Hoberg. et Al.).

The discomfort in undergoing daily social and professional activity of injured individuals and the scale of the problems associated indicates the necessity to reduce or eliminate these side effects, thus, improving patients' satisfaction after treatment (Calderoni DR. Et Al.).

Several methods to control the immediate inflammatory response associated with implant surgery have been described and used, including the use of drugs such as analgesics like reported in the study of Kim et al., 2009, Aznar-Arasa et al., 2012; and de Sousa Santos et al., 2012, corticosteroids, antibiotics and proteolytic enzymes, laser application or physical therapeutic methods like cryotherapy or manual lymph drainage (MLD), (Oliver Ristow et Al. 2014). No single modality of management significantly prevents and/or significantly reduces the occurrence of swelling, pain and trismus without potential undesirable side effects. Therefore further techniques for a better pain, swelling and trismus control should be developed for patients who undergo implant surgery (Williams S, et Al.).

After its introduction in the 1970s, kinesiotape (KT) has increasingly become popular in the treatment of sport injuries and a variety of other conditions. Many orthopaedic surgeons and physiotherapists use the KT in their clinical practice, with many different applications and results.

There are several claims to the effects of KT including recovery of injured muscles and joints, relieving pain, and increasing blood and lymph flow in the injured area. However, there is still little evidence to support these claims and much more research is necessary like in the study of Williams et al., 2012; and Morris et al., in 2012. The use of KT in the management of lymphoedema is gaining popularity. The tape is similar in weight to the epidermis, and lifting the skin, KT improves the blood and lymph flow, removing congestions of lymphatic fluid or haemorrhages. By providing space, fluids are encouraged to move from areas of higher pressure towards the area of lower pressure, guided by the tape to the desired direction of drainage like explain by Kase et al., in 2003 and in many other subsequent studies. However, although

there is significant clinical and practical experience for this approach, there is little published controlled research. The use of this technique may be beneficial in the postoperative period for pain and swelling management after implant surgery, accelerating drainage of tissue reaction or haemorrhages (Kase K, et Al. 2003, Kase K, Stockheimer KR. et Al. 2006).

The aim of the present multicentric study was to evaluate whether the use of KT post implant surgery might have a favorable impact on pain, swelling and other factors related to patient's quality of life during the first week after surgery.

1. IMPLANT SURGERY

For Implantology we considered the set of surgical techniques designed to functionally rehabilitate a patient suffering from total or partial edentulism through the use of dental implants: metallic (titanium) implants surgically inserted in the mandible or maxilla, allow the connection of the prosthesis, fixed or mobile, for the return of the masticatory function.

A dental implant (also known as an endosseous implant or fixture) is a surgical component that interfaces with the jawbone to support a dental prosthesis such as a crown, bridge, denture, or to act as an orthodontic anchor.

Some of them can be of different shapes, inserted in different locations with different techniques and then connected to the implants with different timing (Lekholm U. et Al., Juodzbals G. et Al.).

The endosseous implant is currently the most widespread, and uses implants (implant body proper) cylindrical / conical, more or less threaded on the outside and internal connection varies in conformation for the emerging part (abutment) and more rarely cylinders or cones without external thread but with similar systems of internal connection to the fixture. Depending on the surgical protocol the implant will be submerged or not (transmucosal); according to the timing of use (functionalization) we will have immediate, early, delayed loading (Shavit I, et Al. Mokti, M. et Al.).

The endosseous implant is basically divided into two main schools: the Italian and Swedish. The implantation of the Italian school is historically earlier, less widespread but conceptually it is still just as important as the second. The Italian school was responsible for the introduction of the first implant specifically designed for immediate loading, the introduction of titanium in the production of implants (Stefano M. Tramonte), the introduction of the respect of the biology of peri-implant tissues (Berglundh, T. et Al.).

The Swedish school was responsible for the method of "osseointegration", first developed by Per-Ingvar Branemark, based on the delayed loading and aims to make more manageable the success of implant treatment: involves the use of bone implants and screw-connected prosthetics, with loading after waiting 3-4 months in the mandible and 5-6 in the jaw. The original protocol of Branemark has been variously modified as well as the facilities used to shorten the time of retirement of the plant and ultimately the general time of treatment. The Swedish school has produced important innovations both in production technology and in surgical techniques: adoption of the surface treatments for implant structure, techniques of both bone tissue and mucosa regeneration, techniques for bone augmentation both vertically and horizontally and in general all those surgical techniques designed to prepare the most appropriate implant site (Pjetursson, B. et Al., Bozini, T., et Al., Misch. 2007).

1.1 The history of implantology

The history of implantology has its roots in the mists of time and we do not know exactly when was born for the first time the idea of including an artificial tooth in a socket to replace a lost tooth. Come to us from ancient interesting archaeological findings that testify of shell pieces machined, minerals or bone. More recently, in the

nineteenth century, there were multiple attempts to improve implant therapy but the inadequacy of materials, surgical techniques, anesthetics, the absence of antibiotics and the total lack of knowledge of occlusion principles, caused ineluctably a high degree of failure. In the first half of the twentieth century there was a great number of attempts much more concrete and numerous patents successfully treated. It can be mentioned the patent of Adams of 1938 the first submerged implant, very similar to the next Branemark type, and experiences of Formiggini considered by some the father of modern implantology (1947). In 1961 appeared the first system specifically designed for immediate loading with respect to the biological area and in 1964 was introduced the first titanium implant. In the 60s and 70s appeared the important histological studies of Pasqualini (Branemark et Al.).

In 1972 Garbaccio developed the theory of bicorticalism and designed its system. In 1975 he conceived the Mondani intraoral welder (intraoral welder). The welding method using the intraoral welder has been further improved by Prof. Giorgio Lorenzon since 2004 with successive European patents. These improvements allow to avoid oxidation of the titanium during welding through the use of inert gases. At the end of the seventies, thanks to the studies on osseointegration spread the plant submerged Branemark, that solved some problems prosthetic of immediate load implants. Since that time the implant submerged spread wide for ease, hitherto unknown, with which even inexperienced operators could initiate implantology; submerged plants multiplied and changed at the fastest pace in an attempt to correct some flaws that chronically afflicted them despite the great success. Collaterally implantology was meanwhile growing reconstructive surgery now able to solve many of the bone problems that greatly restricted the use of submerged implants. The modern implantology, whether load immediate or deferred load, discipline is largely experimented and reliable, able to solve almost all the problems of edentulism, that are functional or aesthetic (Markus S. et Al., Jokstad et Al.).

The basis for modern dental implants is a biologic process called osseointegration where materials, such as titanium, form an intimate bond to bone. The implant fixture is first placed, so that it is likely to osseointegrate, then a dental prosthetic is added. A variable amount of healing time is required for osseointegration before either the dental prosthetic (a tooth, bridge or denture) is attached to the implant or an abutment is placed which will hold a dental prosthetic (Col Sk. Et Al., Sinn, D. P. et Al., Col S.K. et Al.).

The primary use of dental implants are to support dental prosthetics. Modern dental implants make use of osseointegration, the biologic process where bone fuses tightly to the surface of specific materials such as titanium and some ceramics. The integration of implant and bone can support physical loads for decades without failure.

For individual tooth replacement, an implant abutment is first secured to the implant with an abutment screw. A crown (the dental prosthesis) is then connected to the abutment with dental cement, a small screw, or fused with the abutment as one piece during fabrication. Dental implants, in the same way, can also be used to retain a multiple tooth dental prosthesis either in the form of a fixed bridge or removable dentures (Maxim Goldman, et Al.).

An implant supported bridge (or fixed denture) is a group of teeth secured to dental implants so the prosthetic cannot be removed by the user. Bridges typically connect to more than one implant and may also connect to teeth as anchor points. Typically

the number of teeth will outnumber the anchor points with the teeth that are directly over the implants referred to as abutments and those between abutments referred to as pontics. Implant supported bridges attach to implant abutments in the same way as a single tooth implant replacement. A fixed bridge may replace as few as two teeth (also known as a fixed partial denture) and may extend to replace an entire arch of teeth (also known as a fixed full denture). In both cases, the prosthesis is said to be fixed because it cannot be removed by the denture wearer (Chen, Y. et Al.).

A removable implant supported denture (also an implant supported overdenture) is a type of dental prosthesis which is not permanently fixed in place. The dental prosthesis can be disconnected from the implant abutments with finger pressure by the wearer. To enable this, the abutment is shaped as a small connector (a button, ball, bar or magnet) which can be connected to analogous adapters in the underside of the dental prosthesis. Facial prosthetics, used to correct facial deformities (e.g. from cancer treatment or injuries) can utilise connections to implants placed in the facial bones. Depending on the situation the implant may be used to retain either a fixed or removable prosthetic that replaces part of the face (Lee, SL 2007, Ruggiero, S. et Al., Webster Tj. Et Al. 2001, 2004).

Dental implant treatment is very widely spread and reliable treatment that provides good clinical results with high success rates over 90% (Lekholm U. et Al., Mavrogenis AF. Et Al., Le Guéhennec L. et Al.).

The most used are those screw-type endosseous, in most cases left submerged under the gum for a reasonable period.

Actually Titanium is commonly used as an implant material as it has high biocompatibility and bonding ability with the bone. These characteristics were found in 1952 by the Swedish scientist Per-Ingvar Brånemark.

Since then, the results of many studies have demonstrated that titanium has high biocompatibility. Titanium has no adverse effect on the human body and bonds readily with the new bone, which penetrates into the titanium surface.

Implant survival rate and prognosis depends on quality of osseointegration as more direct bone-to-metal interface take place without interposition of non-bone tissue (Nanci A, et Al., Piattelli A. et Al.).

The prerequisites to long-term success of osseointegrated dental implants are healthy bone and gingiva. Since both can atrophy after tooth extraction pre-prosthetic procedures, such as sinus lifts or gingival grafts, are sometimes required to recreate ideal bone and gingiva.

However, differences in bonding force between the implant body and bone occur depending on the differences in surface structures of the implant. (Jokstad, et Al. 2009).

Planning for dental implants focuses on the general health condition of the patient, the local health condition of the mucous membranes and the jaws and the shape, size, and position of the bones of the jaws, adjacent and opposing teeth. There are few health conditions that absolutely preclude placing implants although there are certain conditions that can increase the risk of failure. Those with poor oral hygiene, heavy smokers and diabetics are all at greater risk for a variant of gum disease that affects implants called peri-implantitis, increasing the chance of long-term failures. Long-term steroid use, osteoporosis and other diseases that affect the bones can increase the risk of early failure of implants. (Col S.K, et Al., Kumar, M. N. et Al.).

The success or failure of implants depends also on the health of the person receiving it, drugs which impact the chances of osseointegration and the health of the tissues in the mouth. The amount of stress that will be put on the implant and fixture during normal function is also evaluated. Planning the position and number of implants is key to the long-term health of the prosthetic since biomechanical forces created during chewing can be significant (Sinn, D. P, et Al., Chen, Y. Et Al., Lee, SL. Et Al., Ruggiero, S. et Al.).

1.2 Titanium Surfaces and others

Titanium surfaces play an important role in affecting osseointegration of dental implants. Many studies have concluded that certain characteristics of the implant surface play an important role in altering the quality of osseointegration (Kumar, M. N. et Al.).

Since then implants have evolved into three basic types:

Root form implants; the most common type of implant indicated for all uses. Within the root form type of implant, there are roughly 18 variants, all made of titanium but with different shapes and surface textures. There is limited evidence showing that implants with relatively smooth surfaces are less prone to peri-implantitis than implants with rougher surfaces and no evidence showing that any particular type of dental implant has superior long-term success (Branemark. Et Al.).

Zygomatic implants; a long implant that can anchor to the cheek bone by passing through the maxillary sinus to retain a complete upper denture when bone is absent. While zygomatic implants offer a novel approach to severe bone loss in the upper jaw, it has not been shown to offer any advantage over bone grafting functionally although it may offer a less invasive option, depending on the size of the reconstruction required.

Small diameter implants are implants of low diameter with one piece construction (implant and abutment) that are sometimes used for denture retention or orthodontic anchorage.

A typical implant consists of a titanium screw (resembling a tooth root) with a roughened or smooth surface. The majority of dental implants are made out of commercially pure titanium, which is available in four grades depending upon the amount of carbon, nitrogen, oxygen and iron contained (FDA, Spector, L. 2008, Esposito et Al. 2010, Lindhe, Jan. Et Al.).

It is commonly thought that the slightly roughened implant surface allows better osseointegration compared with the smooth implant surface. Moreover nanostructured materials have shown increased cell attachment over microstructured or smooth surfaces (Esposito et Al. 2013, Atieh, M. A. et Al.).

1.3 Implant placement

Most implant systems have five basic steps for placement of each implant. Soft tissue reflection: An incision is made over the crest of bone, splitting the thicker attached gingiva roughly in half so that the final implant will have a thick band of tissue around it. The edges of tissue, each referred to as a flap are pushed back to expose

the bone. Flapless surgery is an alternate technique, where a small punch of tissue (the diameter of the implant) is removed for implant placement rather than raising flaps. (Anthony 2003, Buser. Et Al. 1994, Newman et Al. 2010, Atieh, M. et Al. 2010, Patzelt, S. B. M. 2013).

Drilling at high speed: After reflecting the soft tissue, and using a surgical guide or stent as necessary, pilot holes are placed with precision drills at highly regulated speed to prevent burning or pressure necrosis of the bone.

Drilling at low speed: The pilot hole is expanded by using progressively wider drills (typically between three and seven successive drilling steps, depending on implant width and length). Care is taken not to damage the osteoblast or bone cells by overheating. A cooling saline or water spray keeps the temperature low.

Placement of the implant: The implant screw is placed and can be self-tapping, otherwise the prepared site is tapped with an implant analog. It is then screwed into place with a torque controlled drill, at a precise torque so as not to overload the surrounding bone (overloaded bone can die, a condition called osteonecrosis, which may lead to failure of the implant to fully integrate or bond with the jawbone), (Assunção, W. G. A et Al., Lee, J. Y et Al.).

Tissue adaptation: The gingiva is adapted around the entire implant to provide a thick band of healthy tissue around the healing abutment. In contrast, an implant can be "buried", where the top of the implant is sealed with a cover screw and the tissue is closed to completely cover it. A second procedure would then be required to uncover the implant at a later date (Ferguson 2014, Papaspyridakos, P. et Al.). Remodelling of bone in the form of resorption generally follows the extraction of a tooth. During all stages of atrophy of the alveolar ridge, characteristic shapes result from the resorptive process, as influenced by anatomic alterations in the alveolar bone (Javed, F et Al., Renouard, Frank, De Brandão, M. L. et Al.). Placement of endosseous implants has become an option in comprehensive periodontal treatment plan for both fully and partially edentulous patients, and in cases of compromised ridges, placement of such implants can hamper the overall prognosis of the final prosthesis (Gk Thakral, et Al.).

1.4 Different approaches and timing of implants after extraction of teeth

There are different approaches to placement dental implants after tooth extraction (Jung, R. E. et Al.).

Immediate post-extraction implant placement.

Delayed immediate post-extraction implant placement (two weeks to three months after extraction).

Late implantation (three months or more after tooth extraction).

There are also various options for when to attach teeth to dental implants, classified into:

Immediate loading procedure.

Early loading (one week to twelve weeks).

Delayed loading (over three months)

Many authors have documented a variety of procedures, including guided bone regeneration (GBR), autogenous and allograft blocks, have been used to increase bone volume prior to implant placement. The latest addition to the various ridge augmentation techniques is distraction osteogenesis (DO), (Goodacre, C. J., et Al.).

Dental implants in augmented bone have evolved into an established treatment modality with functional results practically equivalent to implants in native bone¹⁻⁴ (Reza, M. 2007, Esposito M. et Al. 2007, 2013). However, the evidence for the 'real world' practical value of implant-based fixed dentures in terms of long-term functional and esthetic survival in the rehabilitation of edentulous jaws is presently limited. Implantation strictly in native bone requires a certain minimum bone volume and therefore significantly restricts the number of eligible patients. Due to very diverse criteria for decision-making with respect to bone augmentation in general and the specific method in particular, it is impossible to assess or even roughly estimate the number of patients eligible for implantation in native vs. augmented bone (Guo, et Al. 2012, Papaspyridakos, P. et Al.). One of the key success criteria is the achievement and maintenance of a sufficient bone height to support the implant mechanically and provide a sound basis for soft tissues for sustained esthetically pleasing results. A positive correlation between bone height and soft tissue margin are well accepted. From a reconstructive point of view, autologous bone is doubtlessly the ideal material for augmentation, and a substantial body of evidence strongly suggests its suitability; therefore, alternative materials have to be assessed in comparison to autologous bone as the currently most established standard.

However, autologous bone transplantation has one key disadvantage: The bone is harvested from either intra- or extraoral sites, both of which have particular shortcomings. Bone harvesting from the mandibular ramus – the most frequently tapped intraoral bone reservoir – generally shows a low morbidity, but provides a limited bone volume; harvesting from the chin or peripheral sites such as tibia and iliac crest yields more than sufficient amounts of bone but are burdened with a considerable morbidity, e. g. persistent pain and sensory defects (Pjetursson, B. E. et Al.). Therefore, donor site considerations command caution in treatment recommendation, and a material that is not autologous but equivalent in implant integration suitability is obviously of interest and thus subject of prolific research.

Published studies suggest that allogeneic bone grafts may provide such an alternative, but the available evidence currently does not sufficiently support the decision for autologous or allogeneic bone grafting, respectively, requiring further studies and in particular comparative trials (Bozini, T, et Al.).

Recently, it is increasingly understood that 'implant stable *in situ*' is a necessary but not sufficient precaution for treatment success; in fact, in addition to a fulfillment of the desired function, a flawless appearance is paramount at least when the implant is located in the esthetic zone.

From the patients' perspective, the appearance of peri-implant soft tissue and the prosthetic superstructure presents a very important criterion for the success of the implant treatment. In 2003, Vermynen et al. published a study on patient satisfaction with single-tooth implant restorations and stressed that an esthetically satisfactory result from this kind of treatment was a main concern for patients.

Belser et al. criticized the disregard in assessing the appearance of implant-prosthetic restorations in connection with clinical studies. Based on a review of the success of single-tooth implant restorations in the anterior maxilla they came to the conclusion

that ‘the aesthetic result in scientific studies is generally poorly documented and presents no success criteria.’ The authors proposed an esthetic score in order to obtain objective results regarding the esthetic outcome of implant treatments (Markus Schlee, et Al.).

The ‘pink’ (soft-tissue) esthetics of an implant-based restoration is not only a result of the surgical management of the soft tissues during implantation and denture insertion but also a function of the dimensional stability of the bone structures beneath. A satisfactory early result can be seriously marred by bone resorption and subsequent apical relocation of soft tissue margins in the long term. (Thakral G, et Al., Tomisa AP. et Al., Massimo Del Fabbro, et Al., David M. et Al., Bielecki T. et Al., Kavita Hotwani, et Al.).

1.5 Risks and complications short and long term in dental implants

Placement of dental implants is a surgical procedure and carries the normal risks of surgery including infection, excessive bleeding and necrosis of the flap of tissue around the implant. Nearby anatomic structures, such as the inferior alveolar nerve, the maxillary sinus and blood vessels, can also be injured when the osteotomy is created or the implant placed. Even when the lining of the maxillary sinus is perforated by an implant, long term sinusitis is rare. An inability to place the implant in bone to provide stability of the implant (referred to as primary stability of the implant) increases the risk of failure to osseointegration.

First six months, immediate post-operative risks, infection (pre-op antibiotics reduce the risk of implant failure by 33 percent but have no impact on the risk of infection). 36, excessive bleeding¹⁴, flap breakdown (less-than 5 percent).¹⁴, failure to integrate. (Mozzati M. et Al.).

An implant is tested between 8 and 24 weeks to determine if it is integrated. There is significant variation in the criteria used to determine implant success, the most commonly cited criteria at the implant level are the absence of pain, mobility, infection, gingival bleeding, radiographic lucency or peri-implant bone loss greater than 1.5 mm (Papaspnyridakos, P. et Al.).

Dental implant success is related to operator skill, quality and quantity of the bone available at the site, and the patient's oral hygiene, but the most important factor is primary implant stability. While there is significant variation in the rate that implants fail to integrate (due to individual risk factors), the approximate values are 1 to 6 percent (Javed F. et Al.).

Integration failure is rare in most cases, particularly if a dentist's or oral surgeon's instructions are followed closely by the patient. Immediate loading implants may have a higher rate of failure, potentially due to being loaded immediately after trauma or extraction, but the difference with proper care and maintenance is well within statistical variance for this type of procedure. More often, osseointegration failure occurs when a patient is either too unhealthy to receive the implant or engages in behavior that contraindicates proper dental hygiene including smoking or drug use (Jordi Cascos Romeo, et A.).

The long-term complications that result from restoring teeth with implants relate, directly, to the risk factors of the patient and the technology. There are the risks associated with esthetics including a high smile line, poor gingival quality and missing papillae, difficulty in matching the form of natural teeth that may have

unequal points of contact or uncommon shapes, bone that is missing, atrophied or otherwise shaped in an unsuitable manner, unrealistic expectations of the patient or poor oral hygiene. The risks can be related to biomechanical factors, where the geometry of the implants does not support the teeth in the same way the natural teeth did such as when there are cantilevered extensions, fewer implants than roots or teeth that are longer than the implants that support them (a poor crown-to-root ratio). Similarly, grinding of the teeth, lack of bone or low diameter implants increase the biomechanical risk. Finally there are technological risks, where the implants themselves can fail due to fracture or a loss of retention to the teeth they are intended to support.

Criteria for the success of the implant supported dental prosthetic varies from study to study, but can be broadly classified into failures due to the implant, soft tissues or prosthetic components or a lack of satisfaction on the part of the patient. The most commonly cited criteria for success are function of at least five years in the absence of pain, mobility, radiographic lucency and peri-implant bone loss of greater than 1.5 mm on the implant, the lack of suppuration or bleeding in the soft tissues and occurrence of technical complications/prosthetic maintenance, adequate function, and esthetics in the prosthetic. In addition, the patient should ideally be free of pain, paraesthesia, able to chew and taste and be pleased with the esthetics.

1.6 Management in endodontic surgery

Another possible application of the Kinesiotape is endodontic surgery for the treatment of periapical lesions of endodontic origin.

After the introduction of microsurgical techniques in endodontics, there has been an increased interest in developing protocols for improving the root-end management of teeth (Kim 2002). Conversely, less attention has been paid to the surgical management of soft tissues and to patient-related outcomes in the early post-operative phase (Von Arx et al. 2007). Post-operative quality of life of patients is dependent on the degree of pain, tissue swelling, chewing ability, phonetics, and can be of importance for the overall assessment of the treatment success as well as to its acceptance. Pain and swelling are secondary effects that may occur in the immediate post-surgical period (Gutmann & Harrison 1991). About two thirds of the patients treated by the traditional technique without using magnification devices require analgesics during the early post-operative phase (Seymour et al. 1986, Meechan & Blair 1993). Peri-operative pain management is fundamental in any surgical procedure for preserving the patient's psychological welfare. Reducing pain-related discomfort in the immediate postoperative period may enhance the quality of life of the patient (Kim 2009).

Few studies have examined postoperative discomfort after endodontic surgery, reporting that the use of microsurgical technique is associated with less postoperative pain compared with the traditional technique. It may be hypothesized that proper soft tissue management also could be of importance in the control of post-surgical discomfort. Control of postoperative discomfort might enhance the patient's quality of life and treatment acceptance (Rieko Takemae, et Al.). The Although many protocols have been developed for the management of the root end, relatively less attention has been paid to the surgical management of soft tissues and to patient-

related outcomes in the early post-operative phase (3–8). Postoperative quality of life of patients is dependent on the degree of pain, tissue swelling, drug intake, chewing ability, and phonetics and can be essential for the overall assessment of the treatment success as well as its acceptance (M. Del Fabbro et Al.).

Pain and swelling are side effects that might occur in the immediate postsurgical period. About two thirds of the patients treated by the traditional technique without using magnification devices require analgesics during the early postoperative phase (Seferli J. et Al.).

2. NEUROPHYSIOPATOLOGY OF PAIN

One of the most important consideration is to understand the neurophysiopatology of the pain originated into the principles structure of the tooth. The dental pulp is exceptionally richly innervated by trigeminal afferent axons (Byers MR. 1984, 1999), that seem to subserve mostly, if not exclusively, nociceptive function (Jyväskylä E. et Al., Mumford JM, et Al. Närhi M. et Al.). Accordingly, they respond to stimuli that induce or threaten to induce injury to the pulp tissue, and their activation may induce defensive, withdrawal-type reflexes in the masticatory muscles (Matthews B. et Al. Olgart L. et Al. 1988). The pain responses induced by external stimuli can be extremely intense. The dense innervation of the pulp and dentin gives a morphological basis for the high sensitivity of these tissues. In addition to the afferent sensory nerves, the dental pulp is innervated by autonomic sympathetic efferents that play a role in the regulation of the blood flow in the pulp (Olgart L. et Al.) and, in addition, may have regulatory functions in pulpal inflammation (Haug SR. et Al., Shimeno Y. et Al.). The existence and functional significance of parasympathetic innervation are still controversial (Olgart L. et Al. 1993).

2.1 Classification of nerve fibers

Nerves can be divided into different groups according to axon size and structure, which determine the conduction velocities of the individual fibers (Guyton AC. Et Al.) (Table1). In the nervous system the different sized fibers are distributed in a functionally meaningful manner, namely thick myelinated fibers in those nerve tracts where fast conduction is demanded and fine-caliber fibers in those tracts where the speed of conduction is not as critical. For example, the efferent A α -motoneurons, which transmit nerve impulses to the skeletal muscles, have thick myelinated axons and conduction velocities of up to 120m/s (Guyton AC. Et Al.). The afferent A β -type sensory axons (with conduction velocities of 30–70m/s) transmit touch and pressure sensations and, usually, their receptors respond to light mechanical forces, they have low stimulation thresholds (Guyton AC. Et Al.).

Fiber type	Function	Diameter (μ m)	Conduction velocity (m/s)
Aα	Motoneurons Muscle afferents	15-20	70-120
Aβ	Mediation of touch and pressure sensations	5-12	30-70
Aδ	Mediation of pain, temperature and touch	2-5	5-30
C	Mostly mediation of pain	0.4-1.2	0.5-2.5

Table 1. Examples of different nerve fiber types, their functions, diameters and conduction velocities.

Pain is conducted by two different sets of neurons: thin myelinated A δ -fibers with conduction velocities of 5–30m/s and neurons with unmyelinated axons with conduction velocities of 0.5–2.5 m/s. Because of this organization, the sensation perceived in response to noxious stimulation consists of two discrete and different components: first sharp and rather well localized pain mediated by A δ -fibers and then delayed, dull pain that is mediated by C-fibers and can radiate to a wide area surrounding the affected tissue. The poor localization of the C-fiber pain is due to more extensive convergence of the afferent C-fibers, compared to A-fibers, to the secondorder neurons in the brain stem (Mumford JM. et Al.). Under experimental conditions, the temporal discrimination and the quality differences of the two pain components can be demonstrated clearly in response to stimulation of extremities (Mumford JM. et Al.).

The same dichotomy in the quality of pain can be shown when stimulating teeth (Jyväsjärvi E. et Al.), although temporal discrimination is not as obvious because of the short distance between the brain and the site of stimulation. The sensory neurons of the dental pulp have their cell bodies in the trigeminal ganglion (Byers MR. et Al.). The teeth of the upper jaw are innervated by neurons of the maxillary and those of the lower jaw by neurons of the mandibular division of the trigeminal nerve. The pulpal axons are located in the alveolar branches of the nerve and finally enter the pulp through the apical foramen or multiple foramina of the root apex in close proximity to the intradental blood vessels. Several hundred axons per tooth enter the pulp at the root apex; for premolars, this number is close to a thousand (Hirvonen TJ. Et Al., Holland GR. et Al.).

The nerve fibers enter the tooth pulp in multiple bundles that contain both myelinated and unmyelinated axons. The majority of the axons (70–80%) are unmyelinated (Byers MR. et Al., Hirvonen TJ. Et Al., Holland GR. et Al.). Most of the nerve bundles extend to the coronal pulp, branching on their way. The terminal branch endings are located mostly in the pulp/dentin border area of the coronal pulp. A dense network of fine nerve filaments, known as the nerve plexus of Raschkow, is formed close to the odontoblasts. Several nerve terminals also enter the odontoblast layer and many of them extend into the dentinal tubules. Both morphological and functional studies indicate that the fine nerve filaments in the dentinal tubules are mostly terminals of the myelinated intradental axons (Närhi MVO, Närhi M. et Al.). Some of the axons also terminate in the deeper parts of the pulp, often in close proximity to the pulpal blood vessels, and they may have a significant role in the mediation of pulpal blood flow responses to external irritation, as well as in pulp tissue inflammation and repair (Byers MR. et Al., Olgart L.). The terminal branching of the pulpal nerve fibers is extensive. Individual myelinated axons may innervate more than 100 dentinal tubules. Accordingly, innervation of the pulp/dentin border is extremely dense. Both myelinated and unmyelinated fibers terminate as free nerve endings. These are the receptors or nociceptors, which respond to various external stimuli in normal teeth and to the environmental changes and various inflammatory mediators that occur under pathological conditions. As in other tissues, the sensory nerves of the dental pulp contain neuropeptides such as substance P and calcitonin gene-related peptide (CGRP) (Byers MR. et Al.).

Several different neuropeptides have been identified in various parts of the nervous

system (Cereceda F. A. et Al., Lundberg JM.) that act as neuro-mediators or modulators and have significant regulatory effects on impulse transmission in the central nervous system. Many of them have also been shown to function in peripheral tissues as, for example, mediator substances in the effector organs of the autonomic sympathetic and parasympathetic nerves. The sensory neuropeptides in the afferent nerves play an important role in the initial stages of the inflammatory process (neurogenic inflammation) following injury in the peripheral tissues (Olgart L. et Al. 1996, Olgart L. 1996) and also seem to regulate the later stages of inflammation and repair (Byers MR.). The location of the nerve terminals in dentin is limited to the inner 150–200 μm of the tubules. The outer layers of dentin are not innervated. It should also be noted that innervation of the dentin is densest in the coronal part, especially in the pulp tips under the cusps, where about 50% of the tubules have been shown to contain nerve fibers. Many tubules contain several nerve endings (Holland GR. 1986). Considering the structural dimensions of dentin it can be estimated that approximately 15 000–20 000 nerve endings/ mm^2 exist in the pulp/dentin border area at the pulp tip. Innervation of the pulp/ dentin border becomes less dense towards the cervical areas and the number of innervated tubules becomes considerably lower. In addition, the distance that the nerve fibers penetrate into the tubules is much shorter than in the coronal areas. In the root, the innervation of the peripheral pulp and dentin is sparse. In this respect the structural organization of intradental innervation seems to be poorly correlated to the sensitivity of different dentin areas in the clinical situation, namely, that exposed cervical dentin seems to be especially sensitive. However, this obvious discrepancy can be due to differences in the time the dentin has been exposed and in the responses of the pulp–dentin complex to irritation in the coronal dentin compared with the cervical dentin (see section on dentin hypersensitivity below). The variation in dentinal innervation in different parts of the tooth may explain the different types of pain response induced in the coronal versus the root dentin in human teeth (Lilja J. 1980).

Some afferent nerve fibers may branch to innervate both the dental pulp and the adjacent tissues or multiple teeth. Such organization may, to some extent, contribute to the poor localization of dental pain and may also allow neurogenic vasodilation and inflammatory reactions to occur in an area of tissue wider than that affected by the original insult. Correspondingly, within the dental pulp the terminal branching of the nerve fibers may contribute to the spread of the inflammatory reactions (Närhi M. et Al.).

2.2 Peripheral neural changes affecting pain responses in inflamed teeth

As in other tissues, injury to the pulp results in an inflammatory reaction, which is an initial promoter of the healing and repair processes. Stimulation of exposed dentin is able to induce injury, which includes dislocation of the odontoblasts into the dentinal tubules as shown in histological studies (Brännström M. 1963, 1986, Hirvonen T. et Al.). Also, nerve endings located in the tubules or adjacent to the odontoblasts become damaged (Lilja J. et Al. 1982). Such morphological changes are prominent after dehydrating stimuli and clearly show the efficacy of the hydrodynamic link in the mediation of the stimulation effects from the dentin surface to the pulp. Thus, even a light stimulus such as an air blast can, in fact, be noxious to the pulp owing to the amplifying effect of the capillary and

hydrodynamic forces. In spite of the morphological changes with destruction of the odontoblast layer and dentinal nerve endings, the exposed dentin surface remains sensitive in human subjects and intradental nerve fibers in experimental animals maintain their responsiveness to dentinal stimulation (Hirvonen T. et Al.). Thus, dentin sensitivity is not dependent on the existence of intact odontoblasts or nerve endings in the dentinal tubules.

2.3 Neurogenic vasodilation and inflammation

Whenever an insult causes activation of the intradental nociceptors, the initial reaction in the pulp tissue is neurogenic vasodilation mediated by the terminals of the afferent nerve fibers. The propagated action potentials are conducted over the entire cell membrane of the neuron. As a result of orthodromic conduction the impulses reach the trigeminal nuclei and then higher brain centers, including the cortex, to evoke a pain sensation. Antidromic transmission along the collateral terminal branches of the axons results in the release of CGRP and substance P, which induce vasodilation and an increase in the permeability of the blood vessel walls. Because the responses are evoked by the propagated nerve impulses, they are induced immediately by external irritation. Thus, this initial component of the inflammatory reaction is dependent on afferent nerve fibers and is called neurogenic inflammation. The extensive branching of the pulpal afferents also allows a spread of the neurogenic effects in a wider area of the pulp than was originally stimulated. It is also possible that activation of axons innervating the pulp and the surrounding structures may result in a spread of the neurogenic inflammatory reactions between the adjacent tissues in rather early stages of inflammation (Olgart L. et Al.).

2.4 Inflammatory mediators

Many different mediators are activated at different stages during the inflammatory reaction and tissue repair, originating from numerous sources, e.g. various tissue components of the pulp, migrating inflammatory cells and the circulating blood. These mediators have important effects in the regulation of the inflammatory reaction and tissue repair. The neurogenic factors interact closely with other mediators (Olgart L. et Al.), e.g. sensory neuropeptides can induce the release of histamine. Autonomic nerves also seem to be involved and it has been suggested that sympathetic nerve endings form contacts with the afferent nociceptive terminals to prevent the release of sensory neuropeptides by a preterminal inhibitory effect. The sympathetic nerves may also sprout in carious or inflamed teeth and their other mediator neuropeptide Y (NPY) is also able to prevent CGRP release from the nociceptive sensory nerve endings (El Karim IA. et Al. Gibbs JL. et Al., Shimeno Y. et Al.) and, in this way, inhibit the inflammatory reaction. After heat injury, intradental nerves are sensitized and show ongoing firing and increased responses to thermal stimulation. The fact that the induced activation is inhibited by anti-inflammatory drugs indicates that the sensitization is mediated by prostaglandins (Ahlberg KF. et Al.). Serotonin has been shown to sensitize pulpal A-fibers (Närhi M. et Al.). After local application of serotonin into deep dentinal cavities, the responses of A-fibers to hydrodynamic stimulation of dentin are enhanced and they show ongoing activity. Bradykinin and histamine activate pulpal C-fibers. The differential sensitivity of the intradental A- and C-fibers to various inflammatory

mediators may give an explanation of the changes in the type and intensity of the pain symptoms during the progress of pulpal inflammation. The conditions in the pulp tissue, such as alterations in the blood flow and consequently the amount of available oxygen, may also play a role. In general, the unmyelinated C-fibers are more resistant than the myelinated A-fibers to reduced oxygen pressure (Franco-Cereceda A. et Al.), and single-fiber recordings in cats suggest a similar difference in the intradental nerves. Moreover, lowered pH may favor activation of C-fibers via sensitization of TRPV1 receptors (Goodis HE. et Al.) and, in fact, recent electrophysiological recordings indicate that C-fibers get more active while the A-fiber activity is reduced in inflamed teeth of experimental animals (Modaresi J. et Al.). Byers and Taylor 1993 and 2003, (see also: Byers, Suzuki and Maeda,) compared the responses after pulp exposure in denervated and normally innervated rat molars and found that the absence of sensory nerves affected the tissue response significantly. Six days after occlusal pulp exposure, the denervated teeth showed more advanced pulp necrosis and less remaining vascular, vital pulp tissue compared with the control teeth with normal sensory innervation. The results indicate that the existence of intact sensory innervation with its responses to tissue injury may be important for regulation of the inflammatory response and consequently for tissue defense and repair reactions in the pulp.

2.5 Local and central control of pulpal nociceptor activation

Recent studies have revealed a number of local mediators in the peripheral tissues that regulate the inflammatory process and consequently the sensitivity of the nociceptors (Stein C. et Al.). In the dental pulp, for example, peripheral endogenous opioids, somatostatin and noradrenaline have been suggested to possess such effects. As already mentioned another mediator of the sympathetic fibers seems to inhibit the release of CGRP and, thus, may slow down the inflammatory reaction and nociceptor activation (El Karim IA. et Al.). It is indicated that the release of the mediators is closely linked to specific steps in the inflammatory process and is regulated by a negative feedback loop (Olgart L. et Al.). The inhibitory factors may be needed to attenuate the inflammatory reaction and at the same time they inhibit the activation of the pulpal nociceptors. In addition, environmental changes due to alterations in local blood flow are able to modify the responsiveness of the intradental nerves (Närhi M. et Al.).

In addition to the described local factors in the pulp tissue itself, a large number of chemical agents released from carious lesions in decayed teeth and diffusing from the dentin surface through patent tubules may modulate nerve activity (Olgart L. et Al.). Thus, numerous local mechanisms may affect the activation of the intradental nerves and contribute to the wide variability of pulpitis symptoms. Both structural and functional changes in the central nervous system take place following peripheral nociceptor activation in response to tissue injury and inflammation. These changes become more prominent in long-lasting pain and may result in persistent alterations in those parts of the pain pathways that participate in the regulation of pain impulse transmission from the periphery to the higher centers of the brain. Results from psychophysiological studies and neurophysiological experiments indicate that central regulation is also important in various dental pain conditions. The human experiments of Sigurdsson and Maixner (Sigurdsson A. et Al.) showed that radiation

of the pain in pulpitis is via secondary hyperalgesia due to central sensitization. By conditioning painful stimulation of the arm, the secondary hyperalgesia could be abolished and the primary source of the pain more accurately localized.

Electrophysiological studies have shown that noxious stimulation of teeth results in discrete cytochemical responses in the second-order neurons of the trigeminal brain stem nuclei mediating orofacial pain (Byers MR. et Al. 1993). These morphological changes are obvious within a few hours after stimulation of the peripheral nociceptors and may represent the first signs of initial sensitization of the central pain pathways. Injuries to the dental nerves caused by tooth extractions and pulpotomies have been shown to induce long-lasting functional changes in the trigeminal brain stem neurons (Sessle BJ. et Al.). The neurons show increased spontaneous activity and expansion of their peripheral receptive fields, indicating that they have formed connections to peripheral neurons that do not normally activate them. The inflammation and injury in the peripheral tissues may result in changes in impulse transmission in the central pain pathways. It is not known exactly to what extent the central mechanisms play a role in dental pain conditions but they may be significant, especially in cases of long-lasting pain.

3. ALTERNATIVE METHODS TO CONTROL PAIN AND SWELLING

Postoperative swelling following different surgical strategies is an area of great interest (A. E. Villafuerte-Núñez et Al.). The main part of literature on the topic deals with swelling after extraction of low impacted third molar (Sudarshan et Al., A. J. van der Westhuijzen et Al.). Postoperative discomfort may be considered a used term that can nevertheless cause misunderstandings due to its ambiguity (Holland C.S., et Al, Akadiri OA. et Al.). A surgical trauma in the oral cavity always causes tissue injury characterized by hyperemia, vasodilatation, increased capillary permeability with liquid accumulation in the interstitial space and granulocyte and monocyte migration, (Messer EJ. Et Al., Beirne OR. et Al.) due to the increased osmotic pressure in capillaries. Edema is the expression of exudates or transudation, and in surgery, probably both the events occur (. Berne RM. et A., Hupp JR. et Al., Alexander RE. et Al.). Transudation in fact is secondary to blood flow slowing (hyperemia, vasodilatation, stenosis, etc.), while a superimposed infection is responsible for exudates (Berne OR. et Al., Grossi GB. et Al.). Extension of the incision as well as tissue manipulation and length of surgery could affect the entity of swelling. Following dental implant surgery, patients typically experience pain and swelling as a direct consequence of the surgical procedure (Messer EJ. et Al., Curran JB. et Al.). The intensity of these symptoms is dependent upon the degree of tissue damage caused. Both symptoms are closely related, develop in parallel, and share the same physiopathology. Some studies have shown conventional dental implant treatment to be associated with mild or moderate postoperative pain, and patients reportedly experience the greatest pain intensity on the day of the operation. Swelling tends to be mild in minor oral surgery, with a peak intensity after 48 hours. Postoperative pain is of a multifactorial origin, and some of its underlying influencing factors remain unclear. Pain occurs as a result of the nociceptive stimulus produced by surgery, ligament distension, muscle spasms and tissue inflammation in general, all those circumstances related to the surgical operation. Few studies have been published on the factors that can influence or worsen postoperative swelling and pain. In this context, patient gender, age, the type of surgical technique, flapless guided surgery, smoking, and the degree of patient fear and anxiety can all influence pain perception (Sortino F. et Al., A. E. Villafuerte-Núñez, et Al., Thiago de Santana-Santos et Al., Capuzzi P. et Al., Slade GD. Et Al.).

Local anesthetics are a good example of the type of drugs affording maximum patient benefit, since they allow us to perform complex and invasive operations safely and with only minimum pain. Nevertheless, there is a small risk of both local and systemic adverse reactions to local anesthetics.^{8,9} In this sense, their correct use is essential in order to avoid complications (Akadiri OA.eEt Al.). Excess anesthetic volume can be counterproductive in terms of postoperative swelling and pain. Mariano Sánchez-Siles et Al., in their study determine whether the administration of high-volume local anesthesia can influence postoperative pain and swelling, and the degree of patient satisfaction, following dental implant placement. Their conclusion are that the injection of large volumes of local anesthetic in dental implant surgery is associated to higher postoperative pain and swelling scores, and to lesser patient rated satisfaction, compared with patients who receive lesser volumes of anesthetic

(Thomas U. et Al.). Thiago de Santana-Santos et Al., investigated the relationship between preoperative findings and short-term outcome in third molar surgery (Yoshii T. et Al.). Their conclusion was that short-term outcomes of third molar operations (swelling, trismus and pain) differ depending on the patients' characteristics (age, gender and body mass index). Moreover, surgery characteristics such as operating time and tooth sectioning were also associated with postoperative variables. (Tiwana PS. et Al., Limeres J. et Al., Conrad SM et Al.).

3.1 Pain and swelling control after oral surgery

A number of articles have been published on the postoperative findings in oral surgery; however, the relationship between pain and swelling and the hemostatic agent used during the surgical procedure has not been studied to date (Mariano Sánchez-Siles, et Al.). Kvist and Reit C., in a study on decision-making in endodontics, compared pain and swelling after surgical versus nonsurgical retreatment. High pain scores were most frequent on the day after surgery, and swelling likewise reached its maximum level on the first postsurgical day, followed by a progressive decrease in frequency and magnitude. Chong and Pitt Ford, evaluated pain experience following root-end resection and filling with MTA or IRM, and concluded that there was no significant difference in the pain experienced by both treatment groups. The postoperative pain was of a relatively short duration, and its maximum intensity was recorded early in the postoperative period but progressively decreased over time. Peñarrocha et al., in 60 patients subjected to periapical surgery with ultrasound and retrograde filling with silver amalgam, found the greatest prevalence of maximum intensity pain to be recorded during the first two postoperative days; however, at that moment, two thirds of the patients had suffered no pain or mild pain. Likewise, swelling peaked on the second postoperative day, when two thirds of the patient sample showed moderate swelling. García et al. related pain and swelling after periapical surgery to oral hygiene and smoking; they found that patients with poor oral hygiene before surgery presented greater pain and swelling during the first postsurgical hours, and smokers before surgery also suffered more pain. Various materials and techniques have been described for bleeding control during periradicular surgery. Von Arx et Al. introduced the use of Expasyl™, a paste containing aluminum chloride and kaolin and commonly used to produce gingival retraction (Pescatore CA., et Al.). In an experimental study, these same authors (Von Arx et Al) compared the hemostatic efficacy and tissue reactions of bone wax, ferric sulfate, Expasyl™ and a combination of Expasyl™ and ferric sulfate. Expasyl™ alone or in combination with ferric sulfate appeared to be the most efficient agent, and the inflammatory tissue reactions were limited to the bone defects, never extending into the surrounding tissues. In a similar study, Jensen et al. found that the foreign body reactions produced in the presence of Expasyl™ and ferric sulfate did not occur if the bone cavity was refreshed with rotary instruments and irrigation.

3.2 Pharmacologic strategies

Antibiotics

Antibiotic therapy to treat established infection or as prophylactic strategy to prevent

distance site infection or to control postoperative discomfort in third molar surgery is today a broadly accepted indication with documented efficacy (Yoshii T. et Al.). However, the great variability in the pharmacologic administration related to parameters like time and way of administration, posology and chemical structure seems to influence the effectiveness of the postoperative discomfort (Delilbasi C. et Al., Kaczmarzyk T. et Al.). Surgeons use antibiotic prophylaxis, even if some controversies exist in this regard. In a study reported by Halpern et al., (Halpern LR. et Al.) reduction of both alveolar osteitis and inflammation was observed in patients treated with penicillin (15,000 UI/kg bw, IV) or clindamicin (600 mg in subjects allergic to penicillin), 1 h before surgery versus placebo-treated control patients. Administration of amoxicillin (2 g orally), 1 h before surgery, did not result in any improvement in the postoperative period versus untreated controls (Monaco G. et Al.). According to Martin et al., (Martin MV. et Al.) parenteral antibiotic prophylaxis should be applied only in the case of osteotomy, whereas oral surgeons are suggested to limit the use of second- and third-generation antibiotics in maxillo-facial surgery and systemic pathologies (Thomas DW. et Al.). In patients treated with amoxicillin/clavulanic acid (1 g, twice a day, for 5 days before surgery), no significant differences were observed versus patients treated with the same drug for 5 days following surgery (Ataoglu H. et Al.). Several authors discussed the effectiveness of antibiotic prophylaxis, and it seems to be highly recommended for patients who present with a high risk of infection or when traumatic surgical procedures have been performed (Salmerón-Escobar JI. et Al.). Antibiotics are largely used in the postoperative period (Stuart E. Lieblich et Al., Poeschl PW. et Al.). They can be applied topically or administered systematically, but the efficacy of antibiotic treatment in the preoperative period is also highlighted. According to some authors, to obtain results with the antibiotic treatment, they must be administered preoperatively to act when the bacterial infection starts. Topical endoalveolar application of minocyclin 10 mg in bioresorbable poly (D, L-lactide-co-glycolide) lactide sustained-release microspheres] following extraction of third molars, significantly reduces the risk of postoperative infection (Stavropoulos MF. et Al.). In contrast, no significant difference as regards to pain, swelling and trismus was reported in a study which compared no antibiotic therapy with administration of clindamycin 300 mg, three times a day, for 5 days, and amoxicillin/clavulanic acid 1 g, two times a day, for 5 days (Poeschl PW. et Al.). Sekhar et al., using metronidazole, 1 g, 1 h before surgery, and 400 mg every 8 h for 5 days after surgery, reported that antibiotic treatment is not efficacious either in the pre- or postoperative period. However, topical application of covomicyn D resulted in a good control of postoperative swelling in a study carried out in the same patients treated for extraction of the impacted third molars with or without antibiotic therapy (van Eeden SP. et Al.).

According to the literature review, the use of the antibiotics before surgery could be considered a predictable procedure to avoid and control the possible infection related to the surgery. If infection and inflammation are present in the surgical area, an antibiotic therapy seems to give a better clinical compliance of the tissues undergoing surgery. The antibiotic administration before, during and after surgery seems to be a better therapeutic choice for controlling the infection arising in the postoperative period.

Corticosteroids

Most surgeons utilize corticosteroids based on the recognized efficacy to control surgery outcomes and to yield a comfortable post-surgery period (Beirne OR. et Al.). However, there are no definite protocols relative to different molecules or regimens, time and route of administration. Corticosteroids are known to reduce inflammation, fluid transudation and edema (Patten JR. et Al.). They represent the most efficacious anti-inflammatory agents and to this purpose can be used in several different conditions (Holte K. et Al.). However, important adverse effects limit their use in all patients (Goodman LS. et Al.). The mechanism of action of corticosteroids has been largely reviewed by several authors,[7,9,39,40] and those that are preferentially utilized in dentoalveolar surgery include dexamethasone (administered orally), dexamethasone sodium phosphate (IV or IM), dexamethasone acetate (IM), methylprednisolone (orally), methylprednisolone acetate and methylprednisolone sodium succinate (IV or IM). In the past, betamethasone has been used as well (Koerner KR. et Al., Peterson LJ. et Al.). Milles and Desjardins obtained good results with the administration of methylprednisolone (16 mg, orally, 12 h before; and 20 mg, IV, immediately before surgery) against placebo administration as one oral tablet 12 h preoperatively. They also suggested continuing administration of the latter for at least 3 days following surgery.

Tiwana et al. reported data on patients undergoing surgery for extraction of four impacted molars. Patients were divided in two groups: the first group was administered with 8 mg desamethasone IV and the second one with 40 mg methylprednisolone IV. It was concluded that preoperative administration of corticosteroids IV has a better outcome, even in the absence of antibiotic therapy, as suggested by 8% of patients with slight swelling versus 28% in the control untreated group. In contrast, by evaluating the swelling by ultrasonography and CT, Esen et Al. observed a significant reduction with preoperative administration of 125 mg methylprednisolone IV, and 500 mg penicillin orally, for 5 days following surgery. In the same study, adrenal activity was analyzed by measuring plasma cortisol concentrations before surgery and 2 and 7 days post-surgery, leading to the conclusion that corticosteroid therapy was well tolerated if no absolute contraindications were present, did not affect adrenal activity for short period administration, and showed the ability to reduce edema by 42%. However, it is recommended not to exceed the dose of 125 mg and to avoid long-term treatment to preserve adrenal function, as also suggested by Beirne and Hollander. Likewise, Bystedt and Nordenram, suggested avoiding very high dosages, and a maximum 5-day therapy. In contrast, Helhag et al. suggested that 10 mg dexamethasone, two times a day, reduces plasma cortisol levels. A significant 62% reduction of edema has been reported after orthognathic surgery when 1 mg/kg methylprednisolone was administered IV for 24 h, but not for 48 h (ElHag M. et Al.). The efficacy of preoperative administration of 1.5 mg/kg methylprednisolone sodium succinate IV versus that of 3 mg/kg followed post-surgery by 2 million IU oral penicillin V, plus acetoaminophen 500 mg, was evaluated in patients operated for extraction of the lower third molars, bilaterally (Ustün Y. et Al.). No significant differences were observed in inflammation, pain and swelling between the two dosage regimens.

Good results were also obtained with 32 mg methylprednisolone and 400 mg

ibuprofen administered 12 h before and 12 h after surgery respectively (Schultze-Mosgau S. et Al.). Often used in oral surgery are long-acting corticosteroid compounds. Among these, the most frequently used is dexamethasone that is about 25–30 times more potent than cortisol (Messer EJ. et Al.). It is available in oral, parenteral and topical formulations and is largely used in oral surgery pre or only post-surgery due to its high efficacy and long half-life. Postoperative edema can also be controlled with dexamethasone administered in the submucosa. (Grossi GB. et Al.). Submucosal administration of 4 mg dexamethasone 1 h before surgery has been compared with that of 8 mg dexamethasone plus 2 g amoxicillin/clavulanic acid two times a day. Both dosages improved swelling versus untreated groups, but no differences were observed between the two dosage regimens. In striking contrast with this observation, Laureano Filho et Al. reported that in patients undergoing surgery for impacted third molars, administration of 8 mg dexamethasone 1 h before surgery, followed by 750 mg paracetamol every 6 h for 4 days produced a better control of swelling compared to treatment with 4 mg dexamethasone. Dexamethasone has also been administered 1 h before surgery (4 mg orally) and 12 h after surgery (4 mg IV), along with analgesic agents (30 mg ketorolac IV), when pain was present. In this study, treatment with dexamethasone always produced a good control of swelling, as measured 24 and 48 h after surgery. Elhag et Al. reported that administration of 10 mg dexamethasone IM, 1 hour before surgery and 10–18 h later together with antibiotic therapy (400 mg oral metronidazole, administered pre- and post-surgically), significantly reduces swelling when compared to only postoperative treatment, without corticosteroids. Although a significant reduction (50%) of swelling was observed 2 days after surgery in patients treated with 4 mg dexamethasone IM, no effect was present after 7 days. However, when administered 5–10 min before surgery, 4 mg dexamethasone IV was not effective in controlling edema when no antibiotic therapy was associated with it (Laureano Filho JR. et Al.). Several authors report the use of corticosteroids only in the postoperative period. A detailed review of the literature has been reported by Markiewicz et Al. in which all corticosteroids have been compared to methylprednisolone. The effect of treatments administered either immediately or later after surgery has been analyzed. Data obtained report a reduction of 0.6 mm and of 0.5 mm of swelling at 1–3 and 7 days, respectively. However, no significant difference was observed due to the high standard deviations, leading the authors to conclude that corticosteroid administration causes only a slight reducing effect on edema. In a different study, patients were divided into three groups: untreated or treated after surgery with 25 mg prednisolone IM or 25 mg prednisolone IM together with diclofenac. Both treatments produced a reduction of swelling on the 2nd day post-surgery, but it was recommended to reserve this therapy only to those cases in which edema of soft tissue was expected (Buyukkurt MC. et Al.). In line with this, Vegas-Bustamante et al. reported that following extraction of lower impacted third molar, a single treatment of methylprednisolone, 40 mg IM, through intrabuccal injection in the masseter muscle, together with amoxicillin 750 mg, every 8 h for 7 days, and 575 mg metronidazole, orally, every 6 h for 3 days, significantly reduced postoperative swelling when compared to control, untreated group. A similar treatment strategy had already been proposed in 1975 by Messer and Keller, who administered 4 mg dexamethasone in three different parts of the masseter muscle and reported a significant reduction of pain, swelling and trismus. In this study, however, it was not

mentioned whether antibiotics were used. The intramasseter muscle injection has also been adopted by Montgomery et Al. The authors did not report any advantage of this versus systemic administration.

Finally, Graziani et al. analyzed 43 patients undergoing surgery for double impaction of lower third molars and administered with (i) dexamethasone, 4 mg endoalveolar; (ii) dexamethasone, 10 mg endoalveolar; and (iii) dexamethasone, 4 mg in the oral submucosa. Amoxicillin and clavulanic acid, 1 g every 12 h, were added for 5 days. The best control of edema was observed in the group treated with 4 mg dexamethasone endoalveolar.

The investigated studies showed how the effectiveness of the corticosteroid administration before surgery could not be considered as a predictable therapy in order to control the postoperative swelling and edema of the surgical area. However, corticosteroid administration during the surgeries or in the postoperative period seems to give a great benefit for reducing the swelling and postoperative edema.

Surgical techniques

Different surgical strategies have been reported in the literature to reduce the postoperative discomfort after the third molar surgeries. They can be used either separately or in association with pre or postoperative strategies. Different kinds of flaps have been used during extraction of impacted third molars, specifically to assess whether a marginal flap could control postoperative swelling better than a para-marginal one (Suarez-Cunqueiro MM. et Al.). No significant difference in the entity of swelling was observed after using the two kinds of flaps. However, there were no significant differences between the marginal and paramarginal flaps in terms of swelling.

In contrast, Kirk et Al. reported significant differences, particularly for swelling and pain, during the 2nd day post-surgery between a group with a buccal flap and a group with a triangular flap modified by Szmyd. In the latter case, an increased swelling was observed.

Based on the hypothesis that the flap shape could affect postoperative swelling, the response to surgery was analyzed in the same patient undergoing germectomy of the third molars and treated with a triangular marginal and a paramarginal flap (Monaco G. et Al.). However, no significant difference between the two treatments was observed.

In other studies, attention has been focused on the effect of primary or secondary healing on swelling. Pasqualini et Al. have compared 100 patients treated with tight suture with 100 patients sutured after removal of 5–6 mm of mucosa distally to second molar to allow draining. Using this procedure, postoperative swelling was reduced especially on days 2 and 4, while in the group treated with tight suture, the peak of swelling was observed on day 3.

According to several authors, tight closure favors edema formation by creating a unidirectional valve that allows fragments of food to reach the cavity, but not to

leave it easily (Dubois DD. et Al., Holland CS. et Al., de Brabander EC. et Al.). This can be the origin of local infection, inflammation, edema and potential alveolar osteitis and pain for difficult draining (Waite PD. et Al.).

According to other authors, (Cerqueira PR. et Al., Chukwuneke FN. et Al.), different factors such as edema, pain and trismus that follow extraction of impacted third molars can be related to suture technique and to surgery length, and the use of a draining tube can be helpful in reducing or preventing postoperative swelling. This has been confirmed in a study specifically designed to compare postoperative responses in two groups, one treated with suture and the other with draining. In the latter, a clear reduction in edema formation was observed. Rakprasitkul and Pairuchvej, obtained similar results. They reported reduced swelling with suture in the presence of a draining tube when compared to the primary suture.

In a different study, the effect of draining has been compared with methylprednisone treatment (Ordulu M. et Al.). Although no significant differences were reported, pharmacological treatment reduced swelling and was better tolerated by patients. It is then reasonable to conclude that most authors prefer secondary healing and/or draining rather than primary closure.

Different surgical procedures have also been related to postoperative swelling. Osteotomy through piezosurgery has given positive results on tumefaction compared to traditional techniques. However, often, the studies analyzed did not involve extraction of impacted third molars, but general osteotomy of the jaws (Sortino F. et Al., Shearer J. et Al., Robiony M. et Al.).

Cryotherapy

Therapeutic effects of ice applied on a surgery wound are due to changes of hematic flow and consequent vasoconstriction and reduced metabolism (Lee JM. et Al., Price R. et Al.).

In surgery and orthopedics, in fact, the main function of ice on the treated area is to produce vasoconstriction and to control bleeding, resulting in reduced metabolism and control of bacterial growth (Curl WW. et Al., Thermann H. et Al.).

It has to be taken into account that ice applied on an area such as the jaw angle produces rapid chilling in the cutaneous layer, but the effect is much lesser and occurs much later in deep tissues such as the bone (Lehmann JF. et Al., . Sortino F. et Al., Oosterveld FG. et Al.). The application of ice does not have to be too long as this may be responsible for tissue death due to prolonged vasoconstriction, ischemia and capillary thrombosis (Weston M. et Al.).

The first physiological response of tissues to cryotherapy is reduction of local temperature that causes reduced cellular metabolism. In this way, cells consume less oxygen and resist longer to ischemia (Laureano Filho JR. et Al.). In the treatment of impacted third molars, the use of ice shows a good efficacy in reducing post-surgery swelling and pain as demonstrated by several authors.

In contrast, van der Westhuijzen et al. state that there is no scientific evidence to support the use of an icepack in oral and maxillo-facial surgery and report that a slight, but not significant, difference in swelling was observed in patients in whom ice was applied continuously for 24 h after extraction of third molars compared to untreated controls. Similar lack of efficacy has also been reported by other authors (Greenstein G. et Al.).

Moore et Al. report that the application of ice pack following surgery of impacted third molars causes a reduction of 3°C in the oral mucosa, while Nusayr et Al. underlines the importance of the right length of time of cold application. It is interesting to note that low laser dosage (4 J cm²), applied soon after surgery, produces a good control of swelling, especially in patients treated with 4 mg dexamethasone IM (Markovic A. et Al.). However there is growing recognition that the impact of oral conditions on quality of life is an important outcome that can be quite useful in making treatment and post-treatment decisions.

Ali Modabber et Al., in their study compared postoperative cooling therapy applied through the use of cooling compresses with the water-circulating cooling face mask manufactured by Hilotherm in terms of beneficial impact on postoperative facial swelling, pain, eye motility, diplopia, neurological complaints and patient satisfaction. Forty-two patients were selected for treatment of unilateral zygomatic bone fractures and were divided randomly to one of two treatments: either a Hilotherm cooling face mask or conventional cooling compresses. Cooling was initiated as soon as possible after surgery until postoperative day 3 and was applied continuously for 12 hours daily. Facial swelling was quantified through a three-dimensional optical scanning technique. Furthermore, pain, neurological complaints, eye motility, diplopia and patient satisfaction were observed for each patient. Patients receiving a cooling therapy by Hilotherm demonstrated significantly less facial swelling, less pain, reduced limitation of eye motility and diplopia, fewer neurological complaints and were more satisfied compared to patients receiving conventional cooling therapy. The conclusion was that Hilotherapy is more efficient in managing postoperative swelling and pain after treatment of unilateral zygomatic bone fractures than conventional cooling.

3.3 Orofacial Pain after surgery

Head and neck neuropathic pain disorders due to deafferentation are important for dentists, not only because they are confusing to diagnose, but also because they are difficult to treat. They are a serious medical and legal concern as well, because they can occur as the result of treatment that would otherwise not normally cause pain or harm (Spierings EL. et Al., Benoliel R. et Al. 1995).

Neuropathic orofacial pain (NOP) is defined as pain initiated or caused by a primary lesion or dysfunction in the nervous system. NOP has previously been called atypical odontalgia, phantom tooth pain, persistent idiopathic facial pain, or atypical facial pain. A patient afflicted with NOP presents with persistent and severe pain, yet there are no clearly identifiable clinical or radiographic abnormalities. NOP is divided into 2 broad categories: paroxysmal and continuous, and should be distinguished from other types of head and neck pains delineated by the American Academy of

Orofacial Pain (De Leeuw R. et Al. 2007-2008) (Table 2).

TABLE 2. Orofacial pain: diagnosis of symptoms, adapted from the American Academy of Orofacial Pain (AAOP)
Intracranial/vascular pain
Neurovascular pain Neurogenic/neuropathic pain
<ul style="list-style-type: none"> • Paroxysmic painful disorders • Continuous painful disorders
Extracranial pain
<ul style="list-style-type: none"> • Disorders of the eyes, ears, nose and throat • Painful intraoral disorders • Dental and periodontal disorders • Mucogingival, tongue and salivary gland disorders • Painful musculoskeletal disorders
Neck disorders
Maxillary disorders

Etiologies of neuropathic pain vary from local trauma to central nervous system pathologies (Lewis MA. et Al.). Traumatic neuropathies can occur after dental procedures, such as extractions, endodontic treatment, and dental implant insertion (Campbell RL. et Al., Rasmussen PV. et Al.). To date, the prevalence of NOP in the general population is unknown. The available literature, however, indicates a higher prevalence of NOP in women in their late forties (De Leeuw R. et Al.). An earlier review indicated that there is a high female preponderance and concentration of cases in the fourth decade of life. Deafferentation appears to be the most common mechanism of pain, but psychologic factors, alteration of neural mechanisms, and even an idiopathic mechanism have been involved. Not all reported cases have been preceded by trauma to the teeth or gums. No data are available regarding NOP after implant surgery, but in other dental procedures, such as endodontic treatment, its incidence is estimated to be 3%-6% (Campbell RL. et Al., Marbach JJ. et Al.).

The mechanisms for initiation of NOP remain unclear. Some patients have reported that their pain started without any recognizable lesion to the facial structures (idiopathically). The absence of any visible tissue injury, however, does not rule out a neuropathic origin, because several studies have demonstrated that tissue damage is not always necessary to cause disruption to the pain modulation mechanisms of the central nervous system (Benoliel R. et Al.). Generally, deafferentation of the injured nerve produces anesthesia. However, in some cases these injuries produce pain or neuropathic manifestations. Specifically, paroxysmal neuropathies, such as trigeminal neuralgia, are characterized by short electrical or sharp pain. Continuous pain, sometimes of a burning quality, is characteristic of posttraumatic neuropathy and is a common feature in postherpetic neuralgia. Signs and symptoms frequently associated with NOP also include thermal and mechanical allodynia (Lewis MA. et Al., Rasmussen PV. et Al.). Patients suffering from recurrent cluster or migraine headaches may be predisposed to the development of NOP (Vickerz ER. et Al.).

NOP associated conditions include postherpetic neuralgia (shingles) and phantom limb/stump pain. The aberrant developmental neurobiology leading to this pain condition is complex. Neuropathic pain serves no protective function, in contrast to physiologic pain which warns of noxious stimuli likely to result in tissue damage. Relevant clinical features of neuropathic pain include: 1) precipitating factors, such as trauma or disease (infection), and a delay in onset from the initial injury (days to months); 2) complaints of dysesthesias (abnormal unpleasant sensations), burning, paroxysmal, lancinating, or sharp sensations, and pain in an area of sensory deficit; 3) hyperalgesia, allodynia, and sympathetic hyperfunction (on physical examination); and 4) pathophysiologic underpinnings including deafferentation, nerve sprouting, neuroma formation, and sympathetic efferent nerve activity (Vickerz ER. et Al.).

Diagnostic evaluation

Neuropathic orofacial pain is diagnosed after excluding other pathologies that may provoke facial pain in the affected area. Despite the disparity of diagnostic criteria, most authors agree that NOP is a chronic form of facial pain that is normally continuous, deep, poorly localized, and of low to moderate intensity with sporadic episodes of intense pain. Furthermore, in these cases of NOP, radiographs of the face or jaw do not demonstrate any relevant abnormality. NOP can be difficult to diagnose, because of the lack of clinical and radiographic abnormalities. Further difficulties arise if the patient exhibits significant distress and has poor results regarding previous diagnostic tests and treatments, such as somatosensory local anesthetic blockade. Although some neurologic tests are available to confirm NOP, they routinely cannot identify small neuronal abnormalities and are costly. Valuable information can be gleaned by using the McGill Pain Questionnaire, (Melzack R. 1975) which allows the patient to choose words that describe the qualities of his/her pain in a number of important dimensions (sensory and affective). Baseline pain intensity should be measured using the visual analog scale, a simple instrument that can evaluate the efficacy of subsequent treatments. More specific tests necessitate referral to a specialist at a multidisciplinary pain clinic (Michael A.O. et Al., Vickers ER. et Al.).

Nerve injuries

Complications during implant surgery are infrequent when there is adequate diagnostic information and attention to detail is followed during surgery. Three of the most notable complications during surgery include hemorrhage, infection, and neurologic lesions. Injury to the nerve during implant placement is a rare but serious complication (Lamas Pelayo J. et Al.). Variables such as magnification errors, ridge anatomy, and operator technique can increase the chance of complications. Among nerve lesions, damage to the lower alveolar and lingual nerves is the most frequent. These nerve injuries occur directly from drilling procedures, lack of attention to diagnostic information, and/or direct compression of the nerve during implant insertion (Lamas Pelayo J. et Al.). Indirect compression through trabecular bone compression or bone condensation from the implant placement is also a known cause.

Cases have been reported in which NOP has appeared after the positioning of

prostheses over implants (Drangsholt M. et Al.). Kalladka et Al. studied 27 patients who complained of chin paresthesia. They found that 63% of examined neuropathies were secondary to invasive dental procedures (e.g., extractions, implants), 22% to malignant lesions, and 15% to inflammatory pathologies (e.g., periapical periodontitis or infection). They concluded that the most common cause of mental nerve neuropathy was dental treatment followed by malignant metastasis (Kalladka M. et Al.).

Treatment

To prevent nerve damage during the drilling sequence, the routine use of intraoperative periapical radiographs and tomographic images are reliable tools, allowing the operator to confidently adjust the direction and depth of the implant during its placement. Most importantly, it helps to prevent the risk of injury to the nerve in those cases where vertical alveolar bone is limited (Gregg JM. et Al., Lamas Pelayo J. et Al.).

Neuropathic orofacial pain is considered to be one of the most frustrating facial pain conditions confronting medical and dental clinicians(Kalladka M. et Al.). It is very difficult to identify all possible causes, effects or coincidental signs of orofacial pain. To differentiate between the many types of painful phenomena of the head, face and neck, it is essential to use a systematic approach. The patient's psychologic status needs to be considered, and this requires the skill of a clinical psychologist or psychiatrist with clinical experience in pain (Vickers ER. et Al.).

Psychologic variables include distress, depression, treatment expectations, motivation to improve, and background environmental factors. Unnecessary dental treatment to remove the pain, such as extraction, is contraindicated and aggravates NOP (Melis M. et Al., Okeson JP. et Al.). Management of NOP is multidisciplinary and includes physical, psychologic, and pharmacologic treatment (Boychuk DG. et Al.).

Topical medications may be used as a single treatment or in combination with systemic medication for the treatment of patients with chronic neuronal pain disorders in and around the mouth (Padilla M. et Al., Heir G. et Al.). A principal drug for the treatment of NOP is amitriptyline. This drug inhibits the reabsorption of serotonin and norepinephrine, which have been implicated in neuropathic pain (Marabach JJ. et Al., 2000). Phenothiazines, beta-blockers, anticonvulsants, agonists of the GABA receptor, topical medications and minor opiate analgesics also have been used in the treatment of this pain (Forssell H. et Al.).

3.4 Homeopathic and althernative method to control pain and swelling

According to current guidelines, antibiotic treatment is used in implant surgery to reduce the risk of infection (Rory Nolan. et Al.). The rationale for using prophylactic antibiotics prior to oral surgical procedures in patients at risk of endocarditis or in those who are severely immunocompromised is well established (Wah Ching Tan et Al., Sudhakar V1. et Al.).

Recently, a retrospective analysis of 736 implants without antibiotic therapy showed a very good success rate. So many authors explored other strategy and methods. One of that is the *Symphytum officinale* (Comfrey) that is a common garden plant that has been used in herbal medicine for a long time. The homeopathic preparation *Symphytum 6CH* is reported to improve bone healing after trauma or fractures. An *in vivo* digital subtraction radiography study in rats reported a significant increase in radiographic bone density around titanium implants in the initial period of bone healing (Mazzocchi A. et Al.). A Mazzocchi and F Montanaro, make an observational study was to explore the possible effects of *Symphytum 5CH* in the reduction of both pain and swelling after minor implant surgery.

In recent years, antibiotic prophylaxis before invasive dental procedures is less used than in the past. The benefits of antibiotic prophylaxis in patients undergoing routine surgical procedures, such as the placement of endosseous dental implants, are still controversial. There are no randomized controlled clinical studies on antibiotic prophylaxis for dentoalveolar surgery. Studies of less rigorous design report contradictory and controversial results. After antibiotic administration, various adverse reactions may occur, ranging from diarrhoea to life-threatening allergic reactions (Thornhill MH. et Al.). The selection of antibiotic-resistant bacteria is another major concern caused by widespread use of antibiotics. A Spanish study including 461 subjects with drug-induced liver injuries during a 10-year period revealed that the most common medication related to this adverse effect was amoxicillin/clavulate (Laskin DM. et Al.). As reported by Kaczmarzyk, antibacterial drugs should be used only for the management of active infectious diseases or for the prevention of blood-borne infection, such as endocarditis in high-risk patients (Andrade RJ. et Al.). A Cochrane Review has shown no strong evidence for recommending or discouraging the use of antibiotics to prevent infection after a dental implant surgery (Esposito M. et Al.). Nevertheless, clinical practice in Italy is to preventively treat all subjects undergoing an implantation with antibiotics, regardless of the actual risk.

The longevity of implants has been the topic of numerous investigations. In our study, it is remarkable that at post-operative 6-month review healing period, only 3/200 implants failed. A meta-analysis by Pjetursson et al. reported a cumulative survival rate for fixed partial dentures (FDP) supported by implants of 95.4% at 5 years and 86.7% at 10 years after implantation (Pjetursson BE. et Al.). Although the technical complications of FDP have been discussed in recent studies (Kreissl ME. et Al.), implant failure due to infection or lack of osseointegration is still under investigation. Implant loss can be affected by radiotherapy, implant characteristics (diameter and location), high periosteal value at implant insertion and abutment connection (Alsaadi G. et Al.). Titanium can induce hypersensitivity in susceptible patients and this may play a role in implant failure (Siddiqi A. et Al.). Long-term clinical and radiographic follow-up is required, beyond the 6-month period considered in this paper.

According to the literature, postoperative pain medication prescribing correlates to age, insurance covering medication and pre-existing pain (Al-Ouf K. et Al.). There are two case reports of severe pain provoked by the implant itself: neuropathic orofacial pain secondary to nerve impingement due to dental implant (Bach N. et

Al.) and longitudinal section of peripheral nerve in the implant site (Rode D. et Al.).

According to the homeopathic literature, *Symphytum officinale* (Mohabbat O. et Al.), administration is known to favour the consolidation of fractures and help bone formation. A topical herbal ointment is efficacious in the treatment of ankle distortion (Kucera M. et Al.). Allantoin, an ingredient of *Symphytum officinale*, has a particular affinity for periosteum and bone.

An animal study showed a positive effect of *Symphytum 5CH* in the initial stage of bone healing around titanium implants. When administered more than 14 days post-surgery, *Symphytum 5CH* was not effective. These findings led to the hypothesis that it accelerates the rate of mineral deposition up to the hypothetical saturation level (Sakakura CE. Et Al.). Highly diluted homeopathic *Symphytum officinale* (*Symphytum 5CH*), avoids the veno-occlusive hepatotoxicity reported when it is used at high concentration in the form of tea or pure extract for long periods of time. *Symphytum 5CH* treatment may reduce both pain and swelling and could be useful aid in the management of dental implant post-surgery, without side effects. A definitive conclusion would require randomised controlled studies.

3.5 Ozono therapy to control pain and swelling and trismus

Local signs of inflammation, including pain, swelling, and trismus, usually follow the extraction of impacted mandibular third molars. Moreover, this procedure has been used widely as a model for the evaluation of the analgesic efficacy of various drugs and physiotherapeutic means by several authors. The use of ozone has been proposed in dentistry because of its antimicrobial, disinfectant, and healing properties. (Kazancioglu H.O. et Al.). The majority of the previous studies have reported that ozone can reduce the microbial counts in active carious lesions, and therefore it may temporarily arrest the progression of caries, resulting in prevention or delaying the need for tooth restorations.

Huter KM et al.¹⁶ showed that the aqueous form of ozone, as a potential antiseptic agent, showed less cytotoxicity than gaseous ozone or established antimicrobials (chlorhexidine digluconate 2%, 0.2%; sodium hypochlorite 5.25%, 2.25%; hydrogen peroxide 3%) under most conditions. Therefore, aqueous ozone maintains optimal cell biological characteristics in terms of biocompatibility for oral application. However, results are not unanimous regarding the antimicrobial properties of ozone in comparison to common antimicrobials, and Lynch E. has pointed out that studies that have not shown good results with ozone have either not used sufficient doses of ozone, or have used lots of reductants in the culture media, which have preferentially reacted with the ozone.

Avulsed teeth have been irrigated with ozonated water for 2 min and then studied immunohistochemically. It was shown that periodontal cells on the tooth surface remained undamaged and that the root surface was decontaminated.

Not only does ozone therapy have a bactericidal effect, but it can also react with blood components (erythrocytes, leukocytes, platelets, endothelial cells, and the vascular system) and positively affect oxygen metabolism, cell energy, immuno-

modulatory properties, the antioxidant defense system, and microcirculation. Such effects resemble the biostimulatory properties of low-level laser therapy (LLLT), which has been studied widely (Lynch E. et Al.).

The application of gaseous ozone has also been shown to be effective in facilitating oral wound healing following high-dose radiotherapy. Petrucci et Al. reported that the application of 15 days of ozone therapy was beneficial in the treatment of bisphosphonate-related osteonecrosis of the jaws. Agrillo et al. performed 20 tooth extractions in 15 patients with avascular bisphosphonate-related jaw osteonecrosis and reported that ozone was effective when used for 7 days before and after the tooth extraction. In contrast, Matsumura et al. reported that ozone (0.5 g/h for 5 h) did not have a major impact on stimulation of gingival cells for osteoblastic activity in the regeneration of the periodontium around implants. The study of H. O. Kazancioglu, et al. is the first to evaluate the effect of ozone therapy on pain, trismus, and swelling after the surgical extraction of mandibular third molars. Their conclusion was that Ozone has a previously unappreciated but promising impact on the postoperative complications associated with oral surgical procedures. Thus further randomized, controlled clinical studies are warranted for more definitive proof of its efficacy.

3.6 Hyaluronic acid spray on swelling and pain

Hyaluronan or hyaluronic acid (HA) is a biomaterial that has been introduced as an alternative approach to enhance wound healing (Hammad HM. et Al.). HA is a major carbohydrate component of the extracellular matrix and can be found in many tissues (Chen WY. et Al.). It has multifaceted roles in biology, utilizing both its physicochemical and biological properties, and also has many properties that make it a potentially ideal molecule for assisting wound healing: inducing beneficial early granulation tissue formation, inhibiting destructive inflammation during the healing phase, and promoting re-epithelialization and also angiogenesis. By virtue of its non-immunogenicity and non-toxicity, (Moseley R. et Al.), its use has been established in many medical disciplines, such as ophthalmology, dermatology, and rheumatology (Gontiya G. et Al., Laurent TC et Al.). The synthetic form of HA for topical oral use is available in a gel or liquid preparation.

Benzylamine hydrochloride (BnzHCl) is a non-steroidal drug with analgesic, anti-inflammatory, and antimicrobial properties (Polat HB. et Al., Epstein JB. et Al.). Its mechanism of action is not entirely known, but the drug may affect the formation of thromboxanes and alter the rate of prostaglandin production, thereby inhibiting platelet aggregation and stabilizing cell membranes. It is often recommended for the relief of inflammatory conditions of the oral cavity^{14,15} and is commonly used as a mouth rinse or mouth spray at a concentration of 0.15% (Whiteside MW. et Al.).

In their study M. Koray et Al., compared the efficacies of HA and BnzHCl sprays in reducing swelling, pain, and trismus after the surgical extraction of impacted mandibular third molars.

HA is reported to be a very promising candidate for the mediation of periodontal tissue regeneration and wound healing.¹⁰ Topically applied high molecular weight

HA has been shown to induce oral tissue healing after gingival therapy²⁵ and significantly improve oral wound healing at the clinical level in an animal study. Gontiya and Galgali showed that subgingival placement of 0.2% HA gel along with scaling and root planning provided a significant improvement in gingival parameters and reduced inflammatory infiltrate at experimental sites evaluated histologically. In line with these studies, although no evidence of a reduction in pain levels was identified, HA spray appears to offer a beneficial effect on the management of swelling and trismus in the immediate postoperative period following impacted third molar surgery and can be recommended for the patient's postoperative comfort. Further larger randomized placebo-controlled trials are needed to confirm the efficacy of HA in this clinical setting.

3.7 Acupuncture to reducing pain and swelling after dental surgery

Acupuncture ('acus' (needle) + 'punctura' (to puncture)) is the stimulation of specific points along the skin of the body involving various methods such as penetration by thin needles or the application of heat, pressure, or laser light. Acupuncture aims to treat a range of medical and dental ailments, though is most commonly used for pain relief (Devanand Gupta. et Al.). Is one of the "complementary and alternative medicine" (CAM) techniques used to treat a variety of diseases and disorders. Up to one third of the public in many countries has been shown to consult a CAM practitioner at least once a year (Ulett GA et Al.).

Several studies are suggestive of the pivotal role of acupuncture in healing of several diseases and alleviating pain (Richardson PH. et Al.). Literature has proved the role of acupuncture in withdrawal of narcotics. There are several smoking cessation medications and therapies available presently (Newmeyer JA. et Al.). However acupuncture is a recommended alternative procedure, especially where conventional therapies have already failed. We feel, however, that serious consideration of this issue is beyond the scope of this paper. It is thought that acupuncture is a technique involving ancient knowledge of Chinese philosophy and is of no use in dentistry as it works on the placebo concept but the tremendous research on acupuncture has proved it wrong (Lundeberg T. et Al.). Acupuncture is effective in numerous conditions like temporomandibular disorders (TMDs), pain management, and clinical conditions like Sjogren's syndrome (Rosted P. et Al., Ernst E. et Al.). As because the use of acupuncture has evolved since last few decades, Skeptics shrug off the positive effects of acupuncture as merely placebo effects. Believers in acupuncture, however, say that the benefits have simply not yet been proven. Believers promote that the treatment is harmless and can be used as a complement to western medicine.

Published controlled studies on the effect of acupuncture in dentistry are still relatively few, but those which fulfill predefined methodological criteria are reviewed to assess if acupuncture is effective in this field. Anxiety related to dental treatment is rife, and there is a clinical impression that acupuncture can offer an alternative to the sedative drugs commonly used although no controlled Studies are available.

In recent years interest for acupuncture in dentistry has increased at least partly because of published results of its efficacy. However the literature is not extensive

and results vary considerably: from no effect to significant improvement. The main of this article is to discuss and review methodologically the published clinical trials to determine whether clear conclusions can be obtained with the use of acupuncture.

Mechanism of action

Acupuncture prevents and treats diseases by inserting very fine needles into the skin specifically at the anatomic points of the body. The principle behind this concept is that illnesses occur because there is an imbalance in your life force otherwise known as Qi. It is believed that this flows in 14 channels in the human body known as meridians which branch out to bodily organs and functions. If there is a blockage or obstruction in any of them, this is when you succumb to a disease or an illness. The imbalance in the Qi may go one way or the other because of Yin and Yang. The person can only be normal if there is harmony between the two which is what acupuncture is trying to achieve. This can only be restored by stimulating these acupuncture points so your Qi can be adjusted, balanced and harmonized. Apart from using needles, practitioners also use friction, heat, impulses of electromagnetic energy and pressure to stimulate these points in order to balance the movement of energy in the body to reduce one's health.

The mechanism used in Acupuncture basically stimulates the myelinated nerve fibres in muscles which activates midbrain and pituitary-hypothalamus via spinal cord. The various neurotransmitters playing role are Enkephalin, b-endorphin, Dynorphin, Serotonin, and Noradrenalin (Bowsher D. et Al.). The insertion of a needle in an acupuncture point creates a small inflammatory process with release of neurotransmitters such as bradykinin, histamine, etc., and subsequently stimulate A δ fibers located in the skin and muscle. The A δ fibers terminating in the second layer of the black horn inhibit the incoming painful sensations by release of enkephalin. This step acts as a Pain relieving step for Acupuncture (Macdonald A. et Al.). From the second layer of the back horn, the A δ fiber continues to the fifth layer of the black horn, crosses over to the opposite side, and ascends via spinothalamic tract to the midbrain where the raphe magnus nucleus is stimulated.

Management of dental pain (pre-op and post-op), TMDs, oro-facial pain and facial palsy

There are many causes of facial pain and there is often a musculoskeletal component but in general high percentage respond to acupuncture clinically (Chng HS. et Al., Rubik B. et Al.). According to TCM theory, local acupuncture points on facial regions such as ST6 and ST7 and distant points like LI4 can be used to treat dental pain. Acupuncture in dental considerations might not be involved in treating the cause of dental pain but it acts as an adjunct in achieving anesthesia before dental procedures are carried out. In some countries, acupuncture has even been used to replace chemical anaesthesia prior to surgery as there are some patients who are not able to tolerate regular anaesthesia. Studies have shown that the onset time for regional anesthesia after administration of prilo-caine hydrochloride is around 2 min (Kho H. et Al.). A pilot study was conducted to investigate whether the induction time of local anesthetic can be reduced if acupuncture is given before injection (Rosted P. et Al.). In 1995 and 1999 randomized placebo-controlled trials conducted

by Lao et Al. reported that the group that received acupuncture treatment after the surgical removal of impacted lower third molar had significantly longer pain-free postoperative time compared to the placebo group (Lao et Al. 1995-1999). Subjects treated with acupuncture reported 181 min pain-free time compared with 71 min in the placebo group. More randomized controlled clinical trials may be necessary to verify the role of acupuncture therapy in dental pain management, particularly in postoperative pain.

Although acupuncture therapy may not be helpful in treating the cause of TMD but it may aid in relieving the pain caused by TMD and can provide comfort to the patient. It has been documented that acupuncture can help in muscle relaxation and reduce muscle spasms. A systematic review of randomized controlled trials for assessing the efficacy of acupuncture for symptomatic cure of TMDs was conducted (Cho SH. et Al.). Raustia et Al. compared the effectiveness of acupuncture and conventional treatment modalities in the management of TMD and found no difference in the two modalities as far as subjective and objective variables are concerned.

There are several case reports and case series in Chinese literature on successful acupuncture treatment for patients with trigeminal neuralgia. Studies have shown that by the use of filiform needles and using both local and distal points, trigeminal neuralgia can be treated (Lu L. et Al.). Positive results have also been obtained with combined use of three needling and point injections. (Xie JM. et Al.). Researches were also done with the combination of acupuncture and Chinese herbs which also showed positive results (Cai AJ. et Al.).

The use of acupuncture to treat Bell's palsy is based on the TCM concept that needle manipulation at both the local and distal sites can regulate the flow of qi in the meridians, harmonize qi-blood balance, and strengthen the body's resistance to external wind pathogens. It may also help in increasing the excitability of nerves and in promoting the regeneration of nerve fibers. Some local acupuncture points used include ST6 Jiache, located near the angle of the mandible at the prominence of the masseter muscle, and ST7 Xiaguan, located at the depression between the zygomatic arch and the mandibular notch. These two points are found to be anatomically close to branches of the facial nerve (Ly I. et Al.).

Acupuncture for orofacial pain and facial paralysis works primarily through cranial nerve stimulation of primarily the trigeminal and facial nerves, respectively. In treating xerostomia, needles stimulate parasympathetic function. Acupuncture for craniomandibular pain targets sensitive spots primarily in the muscles of mastication. The value of practicing acupuncture from a neurophysiologic perspective is that one can more readily and justifiably extrapolate treatments from humans onto animals, based on neuro anatomically relevant transposition of acupuncture points across species.

Several reports on the use of auricular acupuncture for treating chronic and acute anxiety have shown promising results. There was no difference in the efficacy of Midazolam and auricular acupuncture in the management of anxiety related to dental treatment (Karst M. et Al.).

The stimulation of acupuncture points like PC6 Neiguan and CV24 Chengjiang has proved to significantly reduce gag reflex (Rosted P. et Al). Reports suggest auricular acupuncture to be helpful in treating severe gag reflex (Somri M. et Al). The points known to reduce anxiety are: Top inside of ear (relaxation), Lower inside of ear, just above where the lobe attached to the side of the face (tranquilizer), Lower inside of the ear and near the upper part of the lobe (master cerebral). Stimulation of an acupuncture point on the ear prior to undergoing treatment effectively controls the gag reflex, allowing dentists to perform a variety of procedures without compromising the patient's safety and comfort. More studies should be carried out to verify the effectiveness of acupuncture in controlling gag reflex.

Although, the application of acupuncture has a long history, it still proves to be an effective treatment modality in TCM sector. With the growing acceptance of alternative medicine in Western cultures, acupuncture is quickly becoming a popular practice. More and more people today are choosing acupuncture over western medicine to treat bodily pains, relieve stress, or to promote overall health. In the control of postoperative pain or in the management of TMD and facial pain, it has come out to be a useful alternative to the conventional therapeutic armamentarium of the general dental practitioner. But acupuncture is not risk free. Hematoma may develop if the needle punctures a circulatory structure. It is also possible that pneumothorax may occur if the needle is inserted too deep. There is also the risk of HIV and hepatitis if the needle is not properly sterilized. One must not forget that it is merely an alternative and not a proper form of medical treatment. This means one should still be examined by a professional in the medical field who can determine the severity of the illness or disease. Some physicians may wish to expand the scope of their practice by taking additional training to administer acupuncture. Unfortunately, standards of acupuncture have not been fully approved by the FDA due to many unregulated practices that still exist such as the re-use of needles.

3.8 Quality of life and implantology

In order to properly evaluate the outcome of a medical intervention, it is very important to measure the quality of life (QOL). More attention tends to be paid to the evaluation of medical interventions which are more often associated with life-threatening illnesses than with those that have primarily aesthetic and nutritional function (M. del fabbro et Al.). The use of a systemic evaluation index to assess the effects of dental treatment impacting on the improvement of life function, from a conventional viewpoint, of the elderly has been an uncommon practice. Missing teeth have traditionally been replaced with dentures or bridges. The first dental implant first successfully placed and reported by Branemark in 1965 (Rieko Takemae et Al). Since then, implant treatment has become increasingly applied for tooth replacement worldwide. Titanium implants have the advantage of binding with bone (osseointegration) and are inserted directly into the bone at the site of tooth loss to serve as an artificial tooth root. The general condition of the patient and both the quantity and quality of bone at the implant site must be assessed before the procedure is undertaken

The ability or inability to ingest food orally has a large impact on the general health condition of an individual, both physically and mentally, especially in the earlier,

who frequently have missing teeth. However, the systemic effect of dental treatment have not been adequately evaluated, and these effects are now considered to be significant as ways are being sought to improve the QOL of the elderly. Although improvements in QOL as a result of dental care or implant therapy have been reported (Allen FP. et Al.), few scientific studies have used health utility to investigate the effect of oral health on the state of general health of dental patients. Health-related QOL (HRQOL) measures can be used to assess the effectiveness and quality of medical care, and either disease-specific or generic instruments are used to measure HRQOL, depending on the specific aim of the study. Disease-specific instruments have been developed to evaluate the changes in each specific aspect of a disease, such as specific symptoms, treatment, and medical outcomes. Conversely, generic instruments are used for the quantitative evaluation of a wide range of health statuses, not only those related to disease but also those that give a sense of general health, such as physical functioning in daily life, mental health, social engagement, and social life functions of a patient. This enables generic instruments to be applied in local health surveys, and the results obtained can be compared across various realms of related treatments and conditions, or applied to a variety of diseases. Among the generic instruments used are the Health Utilities Index (HUI) [6], EuroQol (EQ 5D), and MOS 6-Item Short-Form Health Survey (SF-6D) (Brazier J. et Al.), and these are known to be useful in the calculation of quality-adjusted life years (QALYS), (Torrance GW. Et Al.). QALYs are outcomes that are necessary to perform cost utility analyses (CUA) (Drummond MF. et A.). HUI is an instrument for health utility measurement that was developed by G. Torrance and colleagues at McMaster University, Ontario, Canada. The Japanese version has been validated in several studies (Torrance GW. et Al.). HUI assesses eight attributable aspects of QOL, producing one simple value of a multi-attribute utility score for use as an indicator of health status. It is based on the utility theory of von Neumann–Morgenstern, with states of being that are worse than death indicated by negative utility values (Neumann PJ. et Al., Patrick DL. et Al.). Scoring functions are based on a direct method of utility measurement, such as time trade-off or standard gambling method. It contains a questionnaire that is simple to answer and is useful in studies with multiple subjects. This standardized simple questionnaire method has become popular in recent utility measurement studies (Bauuer CA. et Al.).

Investigations of the validity and utility of these generic instruments have indicated that health utility and other studies of medical economics studies should be conducted in each country. Uemura et al. reported on the construct validity of the Japanese HUI3, while O'Brien, Luo et Al., and Naglie et Al. reported on the reliability of the HUI.

The General Health Questionnaire (GHQ) is one of the most common mental health tools in use. The GHQ is a measure of current mental health and has been extensively used in different settings and cultures since its development by D.P. Goldberg in the 1970s. The questionnaire was originally developed as a 60-item instrument, but shortened versions, including the GHQ30, GHQ28, GHQ20, and GHQ12, are now available. Each item is rated on a four-point scale that indicates whether the respondent has recently experienced a particular symptom or behavior: less than usual, no more than usual, slightly more than usual, and much more than usual. For example, the GHQ12 gives a total score of 36 or 12 based on the scoring

method selected. The most common scoring methods are bimodal (0-0-1-1) and Likert scoring style (0-1-2-3).

3.9 Measurement of facial swelling

Some authors in their study used the three-dimensional optical scanner, FaceScan3D (3D Shape GmbH, Erlangen, Germany), to measure facial swelling in volume (ml), (Rana M. et Al.). The three-dimensional optical scanner consists of an optical range sensor, two digital cameras, a mirror construction and a commercial personal computer. The sensor is based on a phase-measuring triangulation method (Gruber M. et Al.). There is no need for special safety precautions for the patient, since the advantage of this optical sensor is its contactless data acquisition accompanied by its high accuracy in the z-direction with 200 μm and a short measurement time of 430 ms. The mirror construction permits the capture of over 180° of the patient's face. The computer program Slim 3D (3D Shape) automatically triangulates, merges and postprocesses the data (Laboureux X. et Al.). The final output is a triangulated polygon mesh that is visualized as a synthetically-shaded or wire-mesh representation (Hartmann J, et Al.). For the volume calculation all patients were photographed with a standard technique for frontal views of the face. Adjustment occurred on the Frankfurt horizontal line, parallel to the floor. Patients sat on a self-adjustable stool and were asked to look into a mirror with standard horizontal and vertical lines simulating a red cross marked on it. The horizontal line was adjusted to subnasale and the vertical line was aligned to the midline of the face. Patients were instructed to swallow hard and to keep their jaws in a relaxed position for the scan. Three-dimensional optical scans were recorded at six points in time: on day 1 after surgery (T1), on day 2 (T2), day 3 (T3), day 7 (T4), day 28 (T5) and day 90 (T6) postoperatively. For each patient we chose time point T6 as a reference, because at this time point swelling of soft tissue could be excluded which otherwise could influence the measurements. Annotations of T1 to T6 were prepared by an error minimization algorithm which applied modified Iterative Closest Point using simulated annealing by the Levenberg-Marquardt algorithm (Besi PJ. Et Al, Zhang Z. et Al.). To minimize disturbance of soft tissue during the registration process only facial areas that were not influenced by the swellings were used for surface matching: the forehead, ears and root of the nose. The geometrical models were aligned with the forehead and the ears.

A. E. Villafuerte-Nuñez, et al., in their paper presented a system that measures the four main variables present in facial edemas: trismus, blush (coloration), temperature, and inflammation. Measurements are obtained by using image processing and the combination of different devices such as a projector, a PC, a digital camera, a thermographic camera, and a cephalostat. Data analysis and processing are performed using MATLAB. Facial inflammation is measured by comparing three-dimensional reconstructions of inflammatory variations using the fringe projection technique. Trismus is measured by converting pixels to centimeters in a digitally obtained image of an open mouth. Blushing changes are measured by obtaining and comparing the RGB histograms from facial edema images at different times. Finally, temperature changes are measured using a thermographic camera. Some tests using controlled measurements of every variable are presented in this

paper. The results allow evaluating the measurement system before its use in a real test, using the pain model approved by the US Food and Drug Administration (FDA), which consists in extracting the third molar to generate the facial edema.

3.10 The biomarkers and measure of the progression of inflammatory process.

Inflammation is understood as the body's protective response to injuries (Abbas A.B. et Al.). If this response is not controlled, it could cause more harm than good, and this occurs in different inflammatory diseases. Chronic inflammatory diseases, collectively, represent the most significant component in terms of human suffering and economic cost in the first world, one in three people is affected by them.

The rapid advances in the inflammatory diseases knowledge and the related medicine have led to new medical treatments and have reduced the suffering in millions of patients (Goldsby R. et Al.).

In the anti-inflammatory drugs, development is necessary to identify specific biomarkers and measure the progression of the inflammatory disease to evaluate the medical results and the safety of the treatment; however, the developed measurement systems do not have an adequate reliability.

Currently there are five representative cardinal signs of inflammation (Amin M.A. et Al.) as follows.

Swelling: increased interstitial fluid and edema formation.

Blushing: redness, due mainly to the phenomena of increasing pressure by vasodilation.

Heat: increment of temperature in the swelled area due to the vasodilatation and increased local consumption of oxygen.

Pain: the pain appears as a consequence of releasing substances capable of causing the activation of nociceptors, such as prostaglandins.

The development of drugs to control and reduce inflammation caused by damage to the human body is continuously performed. These drugs, called nonsteroidal anti-inflammatory drugs (NSAIDs), are a group of drugs that block the prostaglandins synthesis provoking the following effects: anti-inflammatory, analgesic (reduce pain), and antipyretic (reducer fever), (Averbuch M, et Al.). Products that have these properties differ in their side effects and the duration of the effect. Within the research and development of anti-inflammatory drugs, there are generic models to analyze their effects. The third molar extraction pain model is recognized by the US Food and Drug Administration (FDA), and it is frequently used to evaluate analgesic and anti-inflammatory drugs (Mehlich D.R. et Al.).

The techniques currently used to measure the effectiveness of anti-inflammatory drugs are based on vernier calipers. Other techniques are based on using the length of a thread to measure the inflammation distance strategically located between some

marked points in the face of the patient or to measure the distance between two points strategically located on the face.

Based on the need to obtain accurate measurements of the effectiveness of anti-inflammatory drugs, the techniques currently used to measure the signs present in the postoperative edema, due to a third molar extraction, require a technological improvement to get more reliable and trustworthy measurements of these variables.

Many Authors has their focuses on the current scientific interest over the area of pathological inflammatory diseases related to the development of a reliable system that allows studying the measurement of four main variables that influence an adequate edema evaluation: trismus, blushing, temperature, and inflammation, having as a possible application the measurement of the effectiveness of the anti-inflammatory drugs. After the extraction of the third molar, the attack on the oral and perioral soft tissues and detachment of the flap and bone trauma are responsible for the inflammation that, under normal conditions, is more intense 72 hours after the extraction. After this period, inflammation begins to subside and decreases during 48 or 72 hours (Corral I.M. et Al.). This period is used to evaluate the variables present in the postoperative edema. Determining the effectiveness of anti-inflammatory drugs is currently based on measuring only two of the variables presented in the postoperative edema: swelling and trismus, by using different techniques.

Trismus Measurement Methods that used a compass instrument. Currently, trismus assessment is carried out by measuring the maximum interincisal opening using normal and digital Vernier calipers.

Swelling Measurement Methods. Inflammation is a three-dimensional volumetric change difficult to evaluate. Some of the methods that have been used to determine the swelling due to the third molar extraction are:

Laskin method, Calibrators, Photographic method and cephalostat (Petersen. K. et Al.), that is perhaps the most accurate method; however, it is very complicated to implement and requires a series of auxiliary equipment that makes the system more expensive. This method was designed by van Gool et al. in 1975 to demonstrate the lack of precision and consistency of the subjective measurements of the inflammation. And another used by Peterson the Facebow.

There is an area of opportunity to improve the application of new technologies to measure the different variables that determine the effectiveness of anti-inflammatory drugs in facial edemas. This improvement area is based on the measurement of trismus, blush, temperature, and swelling, present in the facial edema, using new technologies and techniques to obtain more accurate and reliably measurements than the ones provided by the commonly used techniques. A. E. Villafuerte-Nuñez, et al. In their study propose a system to make the misurement of the cardinal post-operative signs and symptoms. They propose a method to misure trismus. The trismus is evaluated by measuring the maximum interincisal opening. The proposal presented is based on the mea surement of trismus through digital image processing using the MATLAB software.

The developed technique requires locating the face of a person in a digital image, which is acquired at a fixed distance between the camera and the person by using a metric reference standardized to this distance. Once the image of the person mouth opening is ready, it is necessary to select the distance in the image to be measured using two points selected by the user.

The pixels of the selected distance are converted to centimeters by using the MATLAB software. The pixels to centimeters conversion resolution of the selected distance in the opening mouth image is defined by the distance between the camera and the captured face image.

The proposed technique can achieve reliability similar to the techniques that use digital Vernier calipers. In the conversion process from pixels to centimeters, a centimeter can be represented by different pixel heights of an image, such as 640×480 or 800×600 pixels; the latter is the standard of the images used in this project.

The average of the opening mouth image is between 7 and 8 centimeters, for an 800×600 image 1 pixel represents 0.013cm, and this is small enough to obtain an accurate trismus measurement. The advantage of this proposal is that it is a noninvasive technique that only requires capturing an image of the mouth of the person and selecting the distance to analyze, resulting in a representation in centimeters or millimeters of the maximum mouth opening. The method Proposed to Measure Blush. That measure the change in the color (blushing) of the area affected by edema by analyzing histograms of the facial color images. A digitized image is simply an array of numbers, where every number represents the value of a pixel. All the colors are derived from a combination of the RGB (red, green, and blue) colors in different proportions. The methodology consists of the following steps. A person is placed in a cephalostat that allows standardizing the position of the color images, allowing taking similar pictures.

Different images are taken from the face of the person to whom different shades of blush are applied to simulate changes in coloration due to edemas. The obtained color images are processed using MATLAB to obtain the RGB histograms for every one of the images in order to analyze the changes in the color of the facial skin affected by edema. Comparisons are made about the RGB histograms of the images with different tones of blush; the result is a correlation between 0% and 100%. If the color is similar between two images, the correlation is approximately 100%; if the color between two images is too different, the correlation is about 50% or 60% for every channel.

The method Proposed to Measure Temperature. The application of infrared thermography to study the effectiveness of anti-inflammatory drugs is used for detecting temperature changes in the area between the jaw and the temporomandibular joint, and this measurement is performed during the evaluation period after the extraction of the third molar. The images (thermograms) are captured by the FLIR i7 thermographic camera which provides information about the changes in the surface temperature of the patient's facial area once the third molar was extracted. The alteration in temperature corresponds to the radiation generated due to the changes in the internal cellular metabolism. The application of a thermographic

camera to evaluate changes in the temperature of an edema enables the user to obtain a comprehensive and reliable measurement about the edema evolution, so temperature measurement can be used in the evaluation of the effectiveness of anti-inflammatory drugs.

The technique proposed from this authors consists in measuring inflammation through a three-dimensional reconstruction of the area affected by facial edema using the structured light technique (fringe projection). This reconstruction can provide measurements of the inflammation evolution through the variations in centimeters or millimeters of the inflammation. The proposal consists in performing three-dimensional reconstructions of the interest area of the facial edema evolution after the surgery, such that it generates the three-dimensional reconstruction difference between the initial state of the face before suffering an edema and the state after suffering it. Every difference between the reconstructions shows the evolution of the inflammation in centimeters or millimeters until the shape of the face returns to its initial state (A. E. Villafuerte-Núñez et Al.).

4. KINESIOTAPE APPLICATION

The kinesio tape technique utilizes latex free and quick drying tape designed to mimic the qualities of human skin through its specific thickness and high elasticity (Kase K. et Al. 1997). The tape was developed by Dr. Kenzo Kase, a Japanese chiropractor in the 1970s. (Kase K. et Al. 1997). The material used in the Kinesio tape and the original concept of the taping technique was first introduced in Japan in 1979 and the United States in the 1990s. (Kase K. et Al. 2003). The elastic tape is capable of stretching up to 130-140% of its resting static length ensuring free mobility of the applied muscle or joint. One such elastic tape is called Kinesio Tape, (Kase K. et Al. 1998) long used for rehabilitation and during athletic competition. With its origins in sports science, KT techniques have been applied to support injured muscles and joints, helping to relieve pain (Karlson A. et Al.).

May either be used as a compressive or non-compressive external adjunct to rehabilitation, is approximately the same weight and thickness of skin, and has no medicinal qualities. In addition, Kinesio Tape is reported to be hypoallergenic and, due to its construction, allows the skin to breathe (Osterhues DJ. et Al., Walsh SF. et Al., Hwang-Bo. et Al.).

Dr. Kase claimed that by applying the KT, physiological effects would include a decrease in pain by stimulating the neurological system, restore correct muscle function by supporting weakened muscles, remove congestion of lymphatic fluid or hemorrhages under the skin, and correct misalignment of joints by reducing muscle spasms (Hannah L. et Al., Hacer Hicran et Al. Marcin Krajczyk et Al.). After applying the tape, the taped area forms convolutions, thus increasing the space between the skin and muscles. Once the skin is lifted, the flow of blood and lymphatic fluid is promoted. The KT can be applied to virtually any muscle or joint in the body. However, minimal evidence supports the use of this type of tape in the treatment of musculoskeletal disorders. Documentation relies on very few case series, small pilot reports (Asukawa A. et Al., Kalichman L. et Al.) and research studies performed on healthy participants (Halseth T. et Al., Chang HY. et Al.). These data represent lower levels of clinical evidence. In addition, Dr. Kase described different KT applications believed to aid in neurological and lymphatic disorders (Cerrahlarda et Al., Kenzo Kase, D.C. et Al 1997-1998). The most prevalent lymphatic disorder is lymphatic insufficiency, or lymphedema. Lymphatic fluid is accumulated in the interstitial tissue causing swelling, most often in the arm(s) and/ or leg(s), and occasionally in other parts of the body. The space and lymphatic correction techniques are thought to reduce pressure by lifting the skin and acting as channels to direct the exudates to the nearest lymph duct. Regarding neurological pathologies according to the KT manual, when the application is followed correctly, the taped area can be used to facilitate a weakened or hypotonic muscle, recover sensory deficits, reduce spasticity and relax an overused muscle (Nosaka, K. et Al., Tsai H. et Al., Bialoszewski et Al.).

The cotton, latex-free, adhesive, elastic Kinesio Tex tape is more porous and water resistant than standard athletic tape, allowing patients to wear it for 3 to 5 days after

application.¹ Medical doctors, occupational therapists, physical therapists, chiropractors, and certified athletic trainers have used this taping method when treating orthopaedic injuries, but limited research has been conducted to evaluate the effectiveness. To date, researchers have evaluated range of motion (ROM), pain, quadriceps muscle peak torque, functional hand and arm skills, and proprioception (Murray, H. et Al.). However, the results of these studies on the therapeutic, rehabilitative, and physiologic effects of the KT method have been inconsistent. Some researchers have indicated that KT positively affects ROM, pain, peak torque, and functional hand and upper extremity skills, whereas others investigating proprioception and peak torque found no improvements after tape application. Therefore, further research on KT is warranted.

At present, studying these effects has revealed conflicting data. For example, the KT did not alter muscle activity before, during, or after a sudden inversion perturbation in 43 male athletes balancing on a tilt board. In contrast, following placement of the KT on the anterior thigh of 27 healthy participants, an increase in the bioelectrical activity of the vastus medialis muscle after 24 hours was demonstrated. This effect was maintained for another 48 hours following removal of the tape. There appears to be at least some merit for using the KT as a treatment adjunct (Briem K, et Al., Slupik A. et Al., Huang CY. et Al.). However, according to the evidence-base practice paradigm, careful examination of the current literature is warranted in order to clarify whether the KT has significant clinical benefits. Therefore one of the primary purpose of more study is to do sperimental test of the functionality of the tape application with the aim to reducing swelling and pain in patients.

Little is known of the proprioceptive effects of elastic tape, but it may be anticipated that there will be a facilitatory effect of cutaneous mechanoreceptors as has been noted in the case of athletic tape. This mechanism may be an underlying component in the return of muscle function after injury. Murray, H.et al.

The KT can be applied to virtually any muscle or joint in the body. However, minimal evidence.

KT is thought to improve the blood and lymph flow, remove con gestions of lymphatic fluid or hemorrhages, and thus, its use has gained popularity in the management of lymphedema. Being similar in weight to the epidermis, KT appears to exert its effect on lymphatic drainage by lifting the skin thereby guiding fluids to move from higher pressure to lower pressure areas (Yoshida A. et Al.). The profile and brand recognition of KT increased after the tape was donated to 58 countries for use during the 2008 Olympic Games and therefore used by several high-profile athletes. However, despite the vast clinical experience and clever commercial exploitation of KT, evidence-based scientific publications are surprisingly sparse (Sherrington C. et Al., Thelen MD et Al.). It is conceivable that the application of KT may alleviate the postoperative morbidity of 3M extraction by accelerating drainage of tissue reaction or hemorrhages, a hypothesis this study sets out to investigate.

Kinesio taping has been theorized to lift the skin from the underlying fascia, increasing blood and lymphatic flow,¹ which might result in increased oxygen

allotment to the muscle, decreased inflammation, and improved anaerobic muscle function (Slupik A. et Al.). To date, authors of only 2 studies have examined the effects of KT on muscle function. Slupik et al used peak torque as the dependent variable. Fu et al, used both peak torque and total work. The results of these 2 studies were contradictory. After the application of Kinesio tape, Slupik et al found an increase in isometric peak torque in the vastus medialis muscle, whereas Fu et al found no improvement in either isokinetic peak torque or total work of the quadriceps muscle. Their results might have differed for several reasons. First, they tested different muscles. Second, isometric peak torque was measured in one study, and isokinetic peak torque was measured in the other. Whereas aspects of these studies were different, both groups of researchers examined the effect this taping method had on anaerobic muscle function. An alternative way to evaluate anaerobic muscle performance is by measuring the endurance ratio of a given muscle. Endurance ratio can be altered by the amount of oxygen supplied to that muscle (Sherrington C. et Al.). It is related to anaerobic energy stores in the muscle, energy supply pathways, local circulatory volume, and efficiency. Theoretically, if KT enhances oxygen allotment via increased blood flow, the ability of the muscle to more rapidly perform oxidative metabolism would improve and subsequently would lead to better function of the muscle.^{8–10,17} Improved blood flow and strength also might affect muscle circumference and volume. Based on the result of Hannah L. et al. we conclude that KT did not enhance muscle performance in a healthy population. They found KT did not affect blood circulation or volume of the gastrocnemius muscle. Using 2 different taping methods also did not elicit any changes in dependent variables. Clinically, these results indicated that KT might not enhance muscle endurance in healthy athletes, but future researchers might find potential benefits for the injured individual.

Kenzo Kase, et Al., using the method for the treatment of injuries, with the aim to increasing the amount of blood flow like one of the mechanisms in the healing process. One of his clinical study was based on 9 subjects using a Doppler machine to measure the volume changes of the peripheral blood flow before and after applying Kinesio Taping. Based on the results, applying Kinesio Tape was effective in changing the volume of the peripheral blood flow for subjects that had physical disorders. The result of this research suggests that Kinesio Taping causes the alternation of the blood flow. By applying Kinesio Taping techniques, an immediate effect is seen since the blood flow has been changed immediately (within 10 min.) after taping. Probably more importantly, the result that we were able to gather from this study was that, since the Doppler indicated no major changes in the healthy subjects blood flow after taping, we can say with some confidence that Kinesio Taping has no major adverse effects.

Kayoko, Maruko et al. In their reviews and study discuss and share some of their neurological patient case findings, which will demonstrate the success that can be achieved when using Kinesio Taping as an adjunct for aqua-therapy protocols.

A. Yasukawa, et Al. Using the KT application in their study in the management of abnormal tone of upper extremity and young adults affected by neurological spasticity post botox treatment. Their result demonstrated that the KT had an influence to the wrist extension and abduction and on the pain.

Nosaka, K. At al. In their study had the purpose to apply an eccentric exercise to the brachium flexor group in order to cause a delay onset of muscle soreness (DOMS). The study compared the difference of the DOMS effect, with and without Kinesio Tape applied to the skin. All the measurements demonstrated a tendency that Treatment with tape controlled the muscle damage and assisted in the recovery.

Chen-Yu Huang. At al. Studied the effect of the Kinesio tape to muscle activity and vertical jump performance in healthy inactive people. The results showed that the vertical ground reaction force increased when Kinesio tape was applied even when the height of jump remained about constant. However, the height of the jump decreased, and there was no difference on the vertical ground reaction force in placebo taping group. Although the EMG activity of medial gastrocnemius tended to increase in Kinesio taping group, there are no differences in EMG activity for the medial gastrocnemius, tibialis anterior and soleus muscles in either group.

Hacer Hicran Simsek et Al. In their study determined the effectiveness of Kinesio taping (KT) application added to the exercise treatment of subacromial impingement syndrome (SIS). Taping is used in combination with other physiotherapy methods to reduce pain and improve functional recovery during shoulder rehabilitation. Several types of elastic or rigid tapes and techniques have been developed for this purpose. Kinesio tape (KT) is an elastic tape used to modulate physiological processes such as pain, inflammation, muscle activity, and circulation and to support rehabilitation applications. However, its effectiveness or probable influence on the outcomes of combined exercise therapy is still not clear. In a recent study, Akbafl et al. showed that KT and exercise therapy together yielded better results by increasing the flexibility of the soft tissue in a shorter period when compared with exercise therapy alone in treatment of patellofemoral pain.

Miller and Osmotherly studied patients with shoulder pain lasting for a duration of more than 6 weeks. One group was given exercise and manipulative therapy and compared to a second group on which rigid and elastic tape was applied over the scapula in addition to the exercise therapy. The scapular tape application group had better results in terms of shoulder pain and motion on the second week.

5. MATERIALS AND METHODS

5.1 Research method

A review of the recent literature on kinesiotope was carried out to get an overview of the applications of this technique in the fields of specific interest to this thesis. General terms and specific terms were used to select items of interest.

Three online databases (Cochrane Library, MEDLINE, PEDro) were comprehensively searched up to January 2015. The search query included the terms “kinesio tape”, “kinesio taping”, “kinesiology tape”, “KT”, and “kinesiology taping”, entered with and without spacing between two words. Since KT originated in Japan, it has been widely accepted in many Asian countries. In order to estimate the extent of this relatively new treatment, no restrictions were initially placed on the publications or language. The reference lists of viable studies were cross-referenced in order to identify additional articles undetected in the original medical database searches.

Key Words:

- ✓ Kinesiotape 7 results, 0 significant;
- ✓ Kinesiology tape 28 results, no significant;
- ✓ Tape and pain 829 results, filters: 5 years, human, 255 results;
- ✓ Tape and edema 39 results, filters: 5 years, human, no significant;
- ✓ Tape and lymphedema 2 results, filters: 5 years, human;
- ✓ Tape and odontoiatric therapy, 0 results;
- ✓ kinesio tape effect 17 results, filters: 5 years, human;
- ✓ kinesio tape and post surgery 0 results, filters: 5 years, human;
- ✓ TMJ and tape 1 results, filters: 5 years, human;
- ✓ Orthognathic surgery and tape 2 results, filters: 5 years human;
- ✓ Edema treatment and tape 11 results, filters: 5 years, human;
- ✓ Treatment of post odontoiatric surgical edema, filters: 5 years, human;
- ✓ Facial edema 748 results filters: 5 years, human;
- ✓ Facial post surgery edema 20 results, filters: 5 years, human;
- ✓ Dental implantology and edema 4 results, filters: 5 years, human;
- ✓ Pain and implantology 4 results, filters: 5 years, human;
- ✓ Dental implantology AND edema 4 results, filters: 5 years, human;
- ✓ Measurement of facial edema 40 results, filters: 5 years, human;
- ✓ Vas and facial edema 8 results, filters: 5 years, human;
- ✓ Pain drawing 131 results, filters: 5 years, human;
- ✓ Quality life questionnaire and post dental surgery 12 results, filters: 5 years, human;
- ✓ Effect on edema of kinesio taping 0 results, filters: 5 years, human.

This research showed that in the literature there is a very limited number of studies on the application of kinesiotope in oral surgery procedures, although some items have a high level of evidence.

Studies on KT were included if they satisfied the following criteria:

- 1) The treatment group received KT;

- 2) Only patients diagnosed with musculoskeletal, neurological or lymphatic complaints were included in the study;
- 3) A detailed description of the KT application was provided;
- 4) Detailed eligibility criteria for patients participating in the study were provided;
- 5) Primary outcome measures including at least one of the following parameters: pain, muscle strength or range of motion. Regarding lymphatic pathologies, we included outcome measurement of edema volume.

Studies were excluded based on the following criteria:

- 1) Absence of a comparison group;
- 2) KT application performed solely on healthy participants.

The review literature served to acquire more knowledge about the protocols of application and evaluation of the KT, in order to adjust the protocol of our investigation and to have sound evidence to which the present study could compare.

5.2 Study sample

The present study has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from all patients. Fifty patients were consecutively recruited, over a 12-month period, to participate in this prospective, multicentric, open-label, randomized clinical trial. The inclusion criteria were all patient undergoing implant surgery procedures such as unilateral elevation of maxillary sinus, multiple implant placement, simple tooth extractions, unilateral or bilateral impacted upper and lower third molars extraction. For more demanding surgical procedures patients were submitted to sedation and could undergo day hospital recovery. Exclusion criteria were: patients younger than 18 years, pregnant or lactating women, sensitivities to tape, unwillingness to shave facial hair, known allergies to medication used in the study. Patients developing unforeseen inflammatory reactions after surgery were excluded.

5.3 Study variables

The primary endpoint of the study was to show the effect of the KT in reducing swelling and pain after surgery.

The evaluation protocol was built on the basis of the different approaches to the disease proposed by many authors (Modabber et Al.).

In particular, emphasis was placed on examinations and evaluation scales for which there is a concordance of opinion in the literature and that have as requirements:

- cost containment;
- no risk for the patient;
- easy and fast application;

Swelling

Swelling was determined by Laskin method, which is still considered a reliable method: three measurements were performed during the evaluation period (7 days). In our study such measurements at the following times: one immediately before surgery, another 24 hours after surgery, and the last one 48 hours after surgery. In order to assess the evolution of the inflammation at the determined points, these are

marked with a dermatographic pencil and a 00 thickness suture thread fixed with two clamps (surgical clips). Measurements are made between the interest points marked with the dermatographic pencil. The reference points and distances to be measured are as follows.

- (a) The distance in centimeters from the bottom edge of the earlobe to the midpoint of the symphysis, called: horizontal distance to the symphysis (DHS).
- (b) The distance in centimeters from the bottom edge of the earlobe to the external angle of the mouth, called: horizontal distance to the corner (DHC).
- (c) The distance in centimeters from the palpebral outboard angle to the goniac angle, called: vertical distance (DV). (Fig. 1), (A. E. Villafuerte-Nuñez, et Al., Oliver Ristow et Al. 2014).

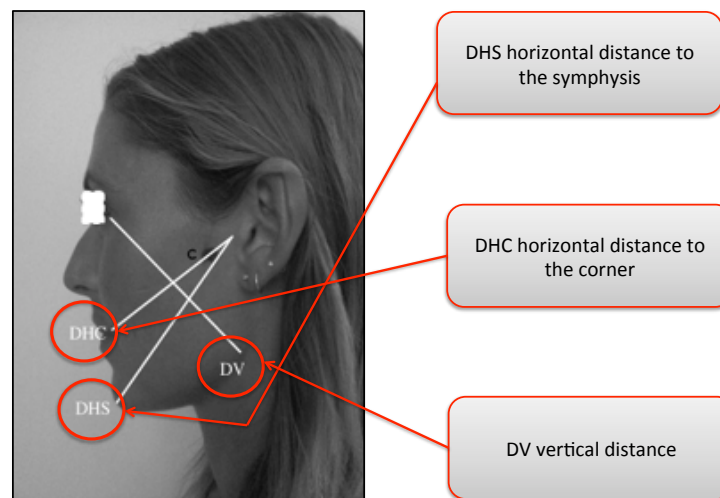


Fig. 1 References points and distances measured for swelling assessment

Trismus

The measure of the functionality of the mouth in open and closure movement was recorded through Trismus Measurement Methods. Historically, different methods to measure trismus have been used. van Gool et Al. used a compass instrument, later replaced with a millimeter ruler, to measure the value of the maximal mouth opening. Sanchez et al. performed a direct measurement of the mouth opening with a millimeter ruler; other approaches to measure the mouth opening are the Willis gauges employed by Yates et Al.

Currently, trismus assessment is carried out by measuring the maximum interincisal opening using normal and digital Vernier calipers. We choose the manual method by millimeter ruler.

Wound healing index

The healing of surgical wound was evaluated according to the following scale:

- | |
|--|
| <ol style="list-style-type: none">1. complete closure and absence of fibrin2. complete closure and slim line of fibrin3. complete closure and presence of fibrin4. complete closure and dehiscence5. complete closure and necrosis |
|--|

Pain

To determining the measure of pain we used a Visual Analogue Scale (VAS), (Gillian A. et Al.). The scale is presented to the patient, who is asked to draw on the line a sign that represents the level of pain experienced. The distance measured in millimeters, starting from the end that indicates the absence of pain, is a measure of pain. The VAS was assessed in the first 3 days post surgery, following the guidelines suggested by other studies (Attachment 1).

Quality of life

We also used the questionnaire of quality of life for evaluating of subjective outcomes regarding discomfort due to tape, movement limitations, subjective feeling of swelling and other patient-related parameters. (Seferli J. et Al., M. del Fabbro et Al.). The quality of life questionnaire was filled by patients up to 7 days post-surgery. (Attachment 1).

Pain drawing

Pain drawings (PDs) are widely used to record subjective pain symptoms. In addition to anamnesis, physical examinations, and results of biomedical tests, they can support to differentiate several types of local pain syndromes, such as chronic low back pain, chronic shoulder pain, neurogenic pain, and headaches (Bo C Bertilson, et Al.). (Attachment 2).

The V.A.S. was supported 24h after surgery from Pain Drawing for the graphic representation of the anatomical localization of symptoms.

Both VAS and Pain Drawing are easily used and sufficiently validated as objective data.

We hypothesized that somatoform-functional pain, is mirrored in distinctive graphic patterns of pain drawings.

We compared the pain groups in terms of pain drawing marks, and sites of pain.

In the latter comparison we distinguished between different sites and frequent marks, and rare marks as described by Niklaus Egloff et. Al.

Definition of pain drawing criteria

The evaluation of all patients was carried out by only one investigator. He was blinded with regard to the pain after surgery. The interpretation of the drawings is based on their graphic features. The criteria included objective aspects only, the form (lines, hatches, circles, and rectangles) the orientation (horizontal lines, symmetrical distribution) and the anatomical area of pain. We took the position with regard to the template border (lines following the contour of the body scheme, or marks exceeding the border of the body scheme) into account. In addition, we considered quantitative criteria (number of marked quadrants, number of pain regions, and number of different marks) as well as the size of the marks (longest mark). Overall, our evaluation included a comprehensive panel of 24 graphic criteria.

1. Number of marked pain regions, 2. Total number of marks, 3. Number of different types of marks, 4. Number of affected quadrants, 5. Number of symmetric marks, 6. Number of “over the border” marks, 7. Length of the longest mark, in mm, 8. Symmetric patterns yes, % 9. Neck involved yes, % 10. Circle mark yes, % 11. Point mark yes, % 12. Long lines yes3), % 13. Strict horizontal mark yes, % 14. Hatching mark yes.

Rarely occurring drawing mark

15. Half-side pattern yes, 16. sternocleidomastoid involved yes, 17. Periorbital pain yes, 18. X mark yes 19. Potato mark yes, 20. Right angle yes, 21. Contour pain yes, 22. Towing bar yes, 23. Radiation neck back yes, 24. Ear crest yes.

Also we included the anatomical local area divided in: head and neck. Head Right Side (HRS), forehead (FH), Backhead (BH), Head Left side (HLS). Neck Right Side (NRS), Front-Neck (FN), Back-Neck (BN), Neck Left side (NLS).

Operation

All surgical procedures were performed by 2 board-certified and specialized dental implant surgeons under local anesthesia using articaine 4% and adrenaline 1:100.000.

Surgery was performed under sterile conditions according to a standardized surgical protocol.

Mucosal wound closure was performed with resorbable sutures (Vicryl; Ethicon Endo-Surgery GmbH, Norderstedt, Germany). Intraoperatively, a single injection of antibiotics was applied (ampicillin 2,000 mg and sulbactam 1,000 mg; Fresenius Kabi AG, Bad Homburg, Germany).

Patients submitted to most demanding surgery, like sinus elevation and extraction of impacted molars, were recovered in day hospital. Patients received routine postoperative instructions: ice pack application for 6 hours after surgery, with alternating periods of application for 30 minutes and no application for 30 minutes. All patients received the same postoperative analgesic drug therapy of paracetamol (Perfalgan; Bristol-Myers Squibb Pharmaceutical Ltd, Uxbridge, Middlesex, UK) 1,000 mg intravenously 2 times per day for 3 days and ibuprofen (Ibu-ratiopharm; ratiopharm GmbH, Ulm, Germany) 600 mg orally (T1, ibuprofen 600 mg 3 times per day; T2, ibuprofen 600 mg 2 times per day; T3, ibuprofen 600 mg 1 time per day; postoperative day 4, ibuprofen 600 mg 1 time per day). Antibiotic treatment was continued with ampicillin and sulbactam (Fresenius Kabi AG) intravenously 3 times

per day for 3 days. Over all the patients kinesio tape was applied with the same protocol.

Taping

All taping procedures were performed by a certified Kinesio Tape therapist (M.M.). The skin was cleaned and freed of moisture and oil before application; if necessary, the area was shaved. All tape applications were performed using skin-colored Kinesio Tape Classic (50 mm 5 m; K-Active Europe GmbH, Wiesthal, Germany). Tape length was measured for each patient starting on the basis of marking points as described in the attachment. Measurement was carried out in a natural relaxed position. The tape was cut to obtain 2 equal strips (3 cm each in width). Tape endings were rounded down. the length of the tape depends on the measurement of the distance of the face points of reference of the patients. The tape was carefully removed from the paper backing to avoid touching the adhesive.

The base of the first stripe was placed following the reference point, C. temporomandibular joint

The apex was placed following the reference point, in the middle from B. nasolabial fold and A. corner buccal. And the extremity ends between the two points.

The base of the second stripe was placed following the reference point, C. temporomandibular joint below and adjacent to the first tape.

The apex was placed following the reference point, D. mental protuberance and finish in the central part of the mental protuberance.

The patient was moved into a natural relaxing position. Tails were placed on the skin with slight tension (20%). Placement of the lymphatic stripes was directed at the appropriate lymphatic duct crossing the mandibular, preauricular, nodes to the area of maximum swelling. After application, the tape was rubbed lightly to activate the medical grade acrylic adhesive. The tape application was left for at least 5 days. Edges were trimmed if the tape lifted before removal. (Attachment 3).

5.4 Data analysis

In addition to the descriptive statistics, the study groups were compared using a 2-sided independent samples t test for differences in means for trismus, swelling, wound healing index, pain. The significance level was set at 5%. The primary endpoint of the study was to evaluate if KT produced a significant decrease of pain and swelling as compared to control in the first week after surgery (see Study Variables for definition). All other statistical tests were secondary endpoints of the study and were performed in an exploratory manner. The Fisher exact test was used to assess statistically the difference between groups for analgesics taken as well as for any variable related to function (eg, mastication, sleeping, speaking) and symptoms (eg, swelling, nausea, bad taste) on each postoperative day.

6. RESULTS

BASELINE CHARACTERISTICS

Fifteen patients (9 female and 6 male); mean age: 57.7 yr; standard deviation (SD): 12.4 yr; age range: 38.6 to 75 yr) were included in the test group and other 15 patients (8 female and 7 male, mean age 56.7 yr; SD 12.1 yr; age range 31.5 to 70.7 yr) were included in the control group. The mean duration of the intervention was 79.0 min (SD=31.5) for the test group and 81.0 min (29.0) for the control group. No significant differences were found between groups regarding baseline characteristics.

The clinical and demographic characteristics of the 30 patients are listed in [Table 1](#).

Table 1. DEMOGRAPHICS AND BASELINE CHARACTERISTICS

	KT (n = 15)	No KT (n = 15)	P Value
Age (yr), means (SD)	57.7(12.4)	56.7(12.1)	0.82
Gender (M,F)	(6/9)	(7/8)	0.71
Arch Sup/Inf	(8/7)	(5/10)	0.27
Duration (mins), means SD	79.0(31.5)	81.0(29.0)	0.86

Abbreviations: KT, kinesio tape; SD, standard deviation.

In the test group surgical intervention were: 10 multiple implant placement for single crown and partial fixed prostheses (1 with regeneration); 1 full arch prosthesis (with regeneration); 1 maxillary sinus elevation; 2 impacted third molar extraction; 1 conventional tooth extraction. In the control group surgical intervention were: 10 multiple implant placement (0 with regeneration); 2 full arch prostheses (both with regeneration); 0 maxillary sinus elevation; 1 impacted third molar extraction; 2 tooth extraction procedures.

TRISMUS

Baseline (T0) mouth-opening values did not differ significantly between the 2 groups (Table 2). The differences between 24h (T1) and baseline (T0) as well as the differences between 48 h (T2) and T0 were significantly different between the two groups. The test group showed a better recovery of mouth opening post surgery.

The clinical changes in trismus of the 30 patients are listed in [Table 2](#) and [Figure 1](#).

Table 2. CHANGE IN TRISMUS

Change in Trismus	KT (n = 15)	No KT (n = 15)	P Value
T0 (pre-surgery)	4.7(1.0)	4.9(0.9)	0.57
T1 (24 h)	4.5(1.0)	4.5(0.9)	0.94
T2 (48 h)	4.4(1.0)	4.4(0.9)	0.90
Diff. T1-T0	-0.2(0.2)	-0.4(0.1)	0.001
Diff. T2-T0	-0.3(0.3)	-0.5(0.1)	0.04

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T0, baseline; T1, 24h after surgery; T2, 48h after surgery.

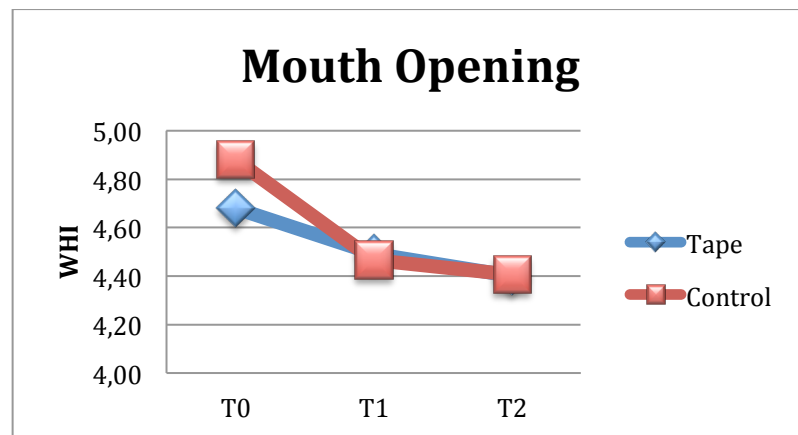


Fig. 1 Diagram showing the trend of Mouth Opening in the two group.

SWELLING

As described in the methods, swelling was represented by four measurement (DHS, DHC, DV,). Baseline (T0) swelling (DHS) values did not differ significantly between the 2 groups (Table 3). The differences between 24h (T1) and baseline (T0) as well as the differences between 48 h (T2) and T0 were not significantly different in the two groups.

The clinical changes in swelling (DHS) of the 30 patients are listed in [Table 3](#), and [Figure 2](#).

Table 3. CHANGE IN SWELLING FROM T0 to T2 - DHS

Change in Swelling	KT (n = 15)	No KT (n = 15)	P Value
T0 (pre-surgery)	14.5(1.2)	14.4(0.9)	0.67
T1 (24 h)	14.9(1.1)	15.0(0.8)	0.66
T2 (48 h)	14.9(1.0)	15.2(0.7)	0.19
Diff. T1-T0	0.3(0.3)	0.6(0.3)	0.003
Diff. T2-T0	0.4(0.5)	1.0(0.5)	0.003

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T0, baseline; T1, 24h after surgery; T2, 48h after surgery.

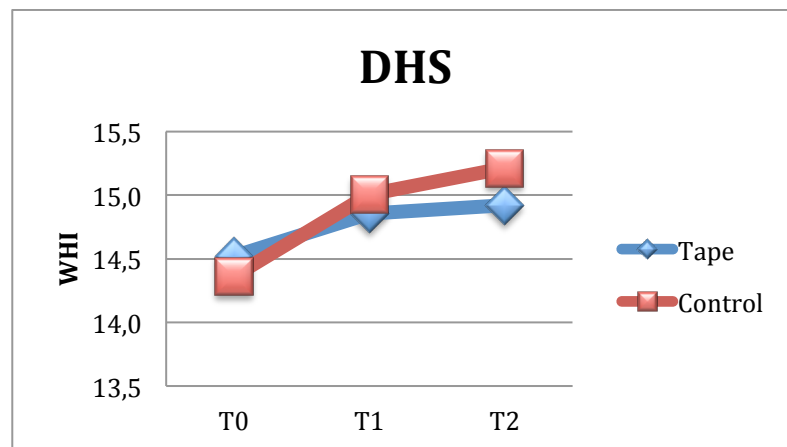


Fig. 2 Diagram showing the trend of DHS in the two group.

The clinical changes in swelling (DHC) of the 30 patients are listed in [Table 4](#), and [Figure 3](#).

Table 4. CHANGE IN SWELLING FROM T0 to T2 - DHC

Change in Swelling	KT (n = 15)	No KT (n = 15)	P Value
T0 (pre-surgery)	10.5(0.8)	10.7(0.8)	0.55
T1 (24 h)	11.0(0.7)	11.4(0.7)	0.13
T2 (48 h)	11.1(0.8)	11.6(0.6)	0.04
Diff. T1-T0	0.4(0.3)	0.7(0.3)	0.04
Diff. T2-T0	0.5(0.5)	0.9(0.4)	0.02

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T0, baseline; T1, 24h after surgery; T2, 48h after surgery.

Baseline (T0) swelling (DHC) values did not differ significantly while at 48h a significant difference was found between the 2 groups (Table 4). The differences between 24h (T1) and baseline (T0) as well as 48 h (T2) and T0 were significantly different between the two groups. The test group showed a lower swelling (DHC) post surgery.

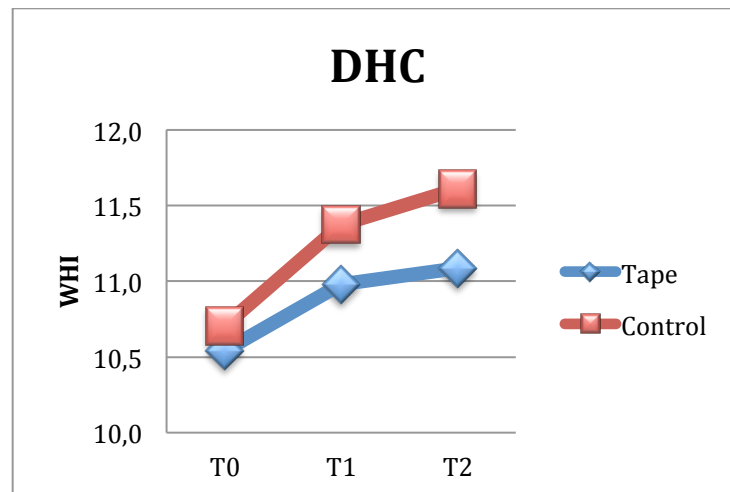


Fig. 3 Diagram showing the trend of DHC in the two group. There are significant differences from the two groups.

The clinical changes in swelling (DV) of the 30 patients are listed in [Table 5](#), and [Figure 4](#).

Table 5. CHANGE IN SWELLING FROM T0 to T2 - DV

Change in Swelling	KT (n = 15)	No KT (n = 15)	P Value
T0 (pre-surgery)	9.4(0.6)	9.7(0.5)	0.16
T1 (24 h)	9.8(0.5)	10.6(0.7)	0.004
T2 (48 h)	10.0(0.7)	10.9(0.7)	0.001
Diff. T1-T0	0.4(0.4)	0.8(0.5)	0.02
Diff. T2-T0	0.5(0.6)	1.2.(0.5)	0.003

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T0, baseline; T1, 24h after surgery; T2, 48h after surgery.

Baseline (T0) condition (DV) values did not differ significantly between the 2 groups (Table 5). The mean DV values at 24h (T1) and 48 h (T2) were significantly different between groups. The differences between 24 h (T1) and T0 as well as the differences between 48 h (T2) and T0 were significantly different between the two groups. The test group showed a lower swelling (DV) post surgery.

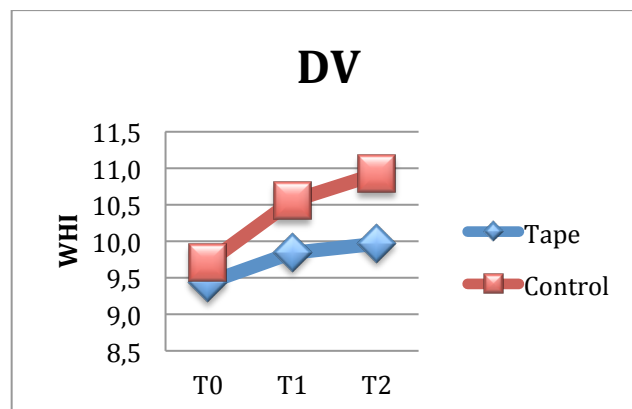


Fig. 4 Diagram showing the trend of DV in the two group. There are significant differences from the two groups.

WOUND HEALING INDEX

The Wound healing index of the 30 patients are listed in [Table 6](#), and [Figure 5](#).

Table 6. CHANGE IN WHI - WOUND HEALING INDEX

	KT (n = 15)	No KT (n = 15)	P Value
T1 (24 h)	1,67(0.82)	1.93(0.70)	0.35
T2 (48 h)	1.73(0.80)	1.60(0.63)	0.62
T3 (7 DAYS)	1.53(0.52)	1.50(0.52)	0.73

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T1, 24h after surgery; T2, 48h after surgery; T3, 7 days,

Baseline (T0) Wound healing index did not differ significantly between the 2 groups (Table 6). The differences between 24h (T1) and 48 h (T2) as well as the differences between 7 days (T3) did not differ significantly between the two groups.

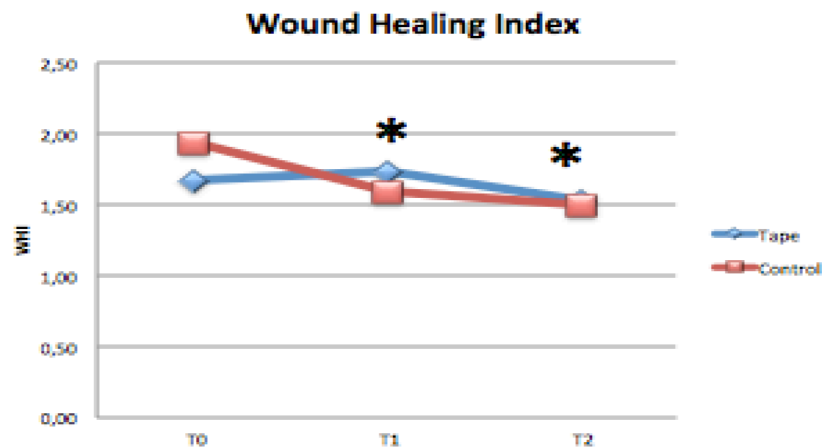


Fig. 5 Diagram showing the trend of WHI in the two group. Asterisks indicate no significant difference between groups.

PAIN – Visual analogue scale (VAS)

Results for pain scores assessed using a 10-level VAS for the KT and no-KT groups are presented in Table 7, and Figure 3.

Patients in the 2 groups after the first day from surgery (T1) showed no significant differences. From day 2 there was statistically significant difference between the 2 groups ($P < .05$).

The between-group differences in VAS score at 48 h (T2) and 7 days (T3) were statistically significant. The test group showed a better recovery of pain (VAS) post surgery.

The Visual Analogue Scale index of the 30 patients are listed in [Table 7](#), and [Figure 6](#).

Table 7. CHANGE IN V.A.S. – VISUAL ANALOGUE SCALE

	KT (n = 15)	No KT (n = 15)	P Value
T1 (24 h)	1,67(0.99)	1.80(0.80)	0.69
T2 (48 h)	0.70(0.65)	1.37(0.69)	0.01
T3 (7 DAYS)	0.27(0.46)	0.87(0.61)	0.005

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; T1, 24h after surgery; T2, 48h after surgery, , T3, 7 days,

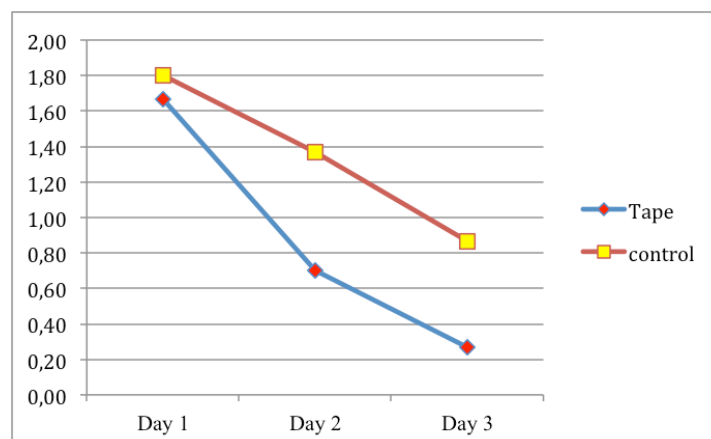


Fig. 6 Diagram showing the trend of pain levels in the two groups, assessed by means of a visual analog scale (VAS). Asterisks indicate significant difference between groups.

PAIN – Pain drawing (PD)

The Values of PD of the 30 patients are listed in Table 8, and Figure 7,8.

Table 8. CHANGE IN PAIN DRAWING

Change in PD	KT (n = 15)	No KT (n = 15)	P Value
HRS Head Right Side	0.4(0.5)	0.5(0.5)	0.49
FH fronthed	0.5(0.5)	0.7(0.5)	0.28
BH Backhead	0.3(0.5)	0.5(0.5)	0.29
HLS Head Left side	0.3(0.5)	0.4(0.5)	0.72
NRS Neck Right Side	0.3(0.5)	0.5(0.5)	0.28
FN Front-Neck	0.3(0.5)	0.4(0.5)	0.46
BN Back-Neck	0.0(0.0)	0.1(0.4)	0.16
NLS Neck Left side	0.4(0.5)	0.4(0.5)	1

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; PD pain drawing; HRS Head ricght side; FH Fronthead; BH Backhead, HLF Head left side; NRS Neck ricght side; FN Front-neck BN back-nek; NLS Neck left side.

Patients in the 2 groups showed no significantly differences.

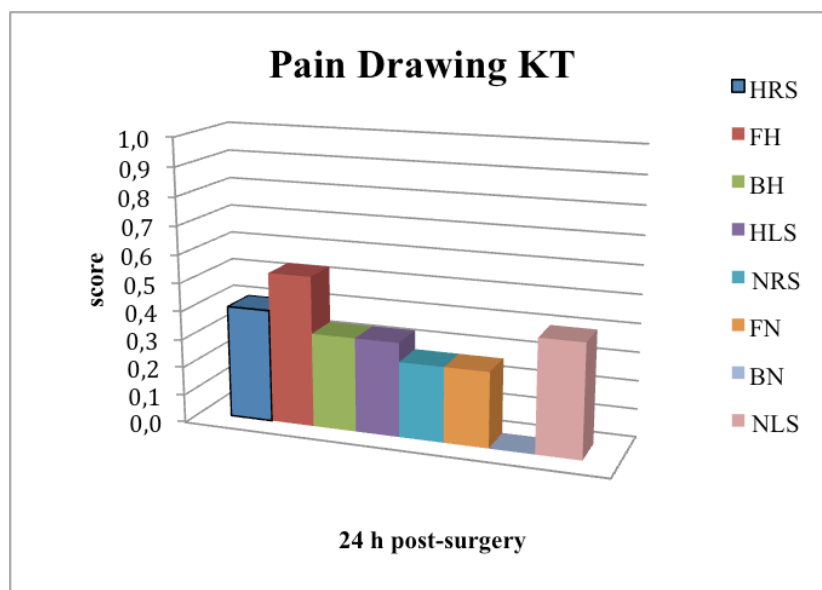


Fig. 7 Diagram showing the trend of PD in the KT group.

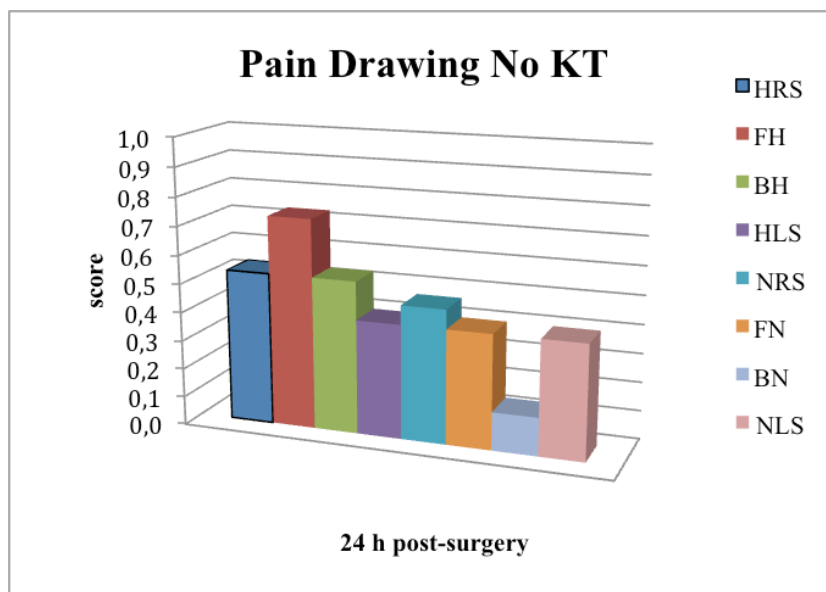


Fig. 8 Diagram showing the trend of PD in the No KT group.

Typical drawing marks. Fig.9,10,11.

In the Figure 9,10,11 are showed the index of drawing marks and the index of the unspecific marks.

Index of drawing marks ear crest sternocleidomastoideus periorbital pain pain in the neck contour pain strikt horizontal mark long lines radiation hand point mark Right angle	Index of the unspecific marks circle mark potato mark m. over the border mark x – mark hatching mark
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Fig. 10 Index of the unspecific marks.

Fig. 9 Index of the discussed drawing marks

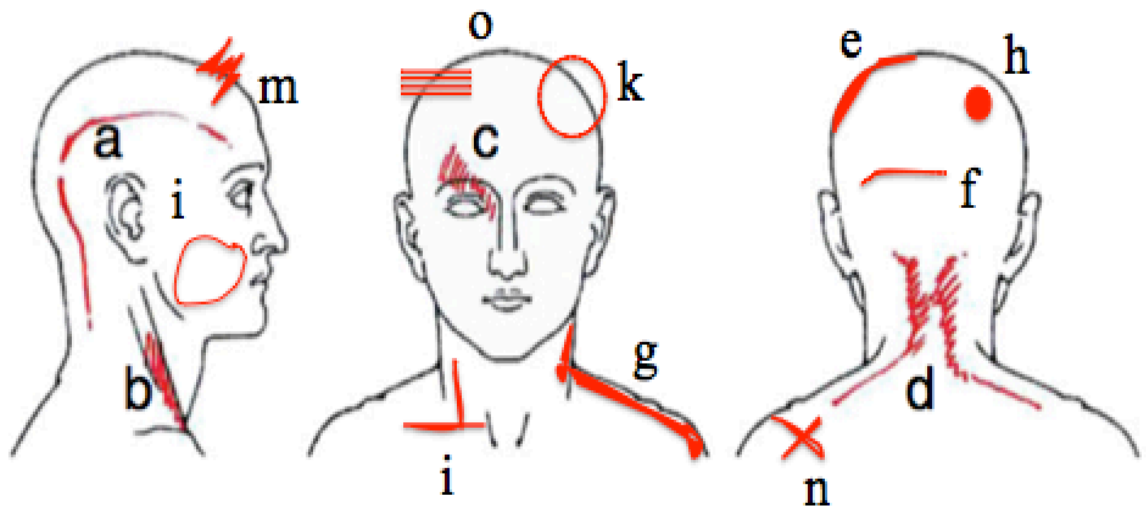


Fig. 11 Gives a graphic index of the investigated PD marks. A selection of representative examples of somatic-nociceptive and somatoform-functional PDs.

In Table 9 are resumed the mean values and SDs of the parameters related to pain drawing evaluation. The KT group showed slightly better (lower) values but they were not significantly different as compared to control group.

Table 9 PAIN DRAWING CRITERIA IN GROUP KT AND CONTROL

Frequently occurring drawings marks

Pain drawing criteria	Somatoform-functional pain (n=15) KT	Somatoform-functional pain (n=15) No KT	P Value
1. Number of marked pain regions	8.7(7.1)	10.2(7.4)	>0.05
2. Total number of marks	12.5(6.8)	15.3(4.8)	>0.05
3. Number of different types of marks	2.6(1.3)	3.0(1.5)	>0.05
4. Number of affected quadrants	3.1(1.1)	3.2(1.1)	>0.05
5. Number of symmetric marks	5.9(5.2)	6.1(7.5)	>0.05
6. Number of “over the border” marks	3.4(2.2)	2.3(2.0)	>0.05
7. Length of the longest mark, in mm	31.2(20.0)	34.4(23.0)	>0.05
8. Symmetric patterns yes, %	5.0	6.0	>0.05
9. Neck involved yes, %	10.2	9.0	>0.05

10. Circle mark yes, %	32.3	34.6	>0.05
11. Point mark yes, %	23.7	22.4	>0.05
12. Long lines yes³⁾, %	24.0	25.0	>0.05
13. Strict horizontal mark yes, %	15.0	16.0	>0.05
14. Hatching mark yes, %	5.0	2.0	>0.05
Rarely occurring drawing mark	20.1	18.0	>0.05

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; PD pain drawing;

QUALITY OF LIFE

The measurement were analyzed in both groups.

For most parameters the use of KT proved to be beneficial to patients, reducing the discomfort in the post-surgical period, especially regarding mouth opening, mastication, sleeping, body temperature rise.

The use of KT produced some light discomfort regarding the sensation of skin color alteration and speaking. Overall, though in most cases no statistical significance was achieved, the KT was well accepted by patients and produced appreciable improvement of postoperative quality of life.

Table 10. CHANGE IN QoF - QUALITY OF LIFE

QoL	Group	day 1	day2	day3	day4	day5	day6	day7
DMO	KT	2,07	1,80	1,40	1,20	0,73	0,53	0,47
	No KT	3,33	3,00	2,60	2,13	1,53	1,27	1,13
DM	KT	1,87	1,73	1,27	0,87	0,60	0,53	0,47
	No KT	2,47	2,47	2,40	2,40	1,07	0,60	0,53
DS	KT	0,53	0,53	0,53	0,40	0,33	0,27	0,20
	No KT	0,73	0,53	0,40	0,27	0,20	0,07	0,07
DSP	KT	0,07	0,07	0,07	0,07	0,00	0,00	0,00
	No KT	0,67	0,60	0,60	0,40	0,27	0,13	0,13
SW	KT	0,13	0,07	0,00	0,00	0,00	0,00	0,00
	No KT	0,60	0,53	0,53	0,33	0,33	0,27	0,13
DA	KT	0,40	0,20	0,00	0,00	0,00	0,00	0,00
	No KT	0,40	0,33	0,27	0,13	0,13	0,13	0,13
SR	KT	1,40	1,40	1,20	0,73	0,40	0,20	0,20
	No KT	2,00	2,00	1,53	1,00	1,00	1,00	1,00
NS	KT	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	No KT	0,20	0,20	0,20	0,20	0,13	0,07	0,07
BT	KT	0,13	0,13	0,07	0,07	0,00	0,00	0,00
	No KT	0,33	0,33	0,33	0,33	0,20	0,07	0,07
A	KT	1,60	1,33	1,33	1,20	0,67	0,53	0,33
	No KT	2,07	2,07	1,87	1,47	1,00	0,87	0,40
B	KT	0,13	0,07	0,07	0,00	0,00	0,00	0,00
	No KT	0,07	0,00	0,00	0,00	0,00	0,00	0,00
SCA	KT	0,40	0,67	0,67	0,60	0,53	0,53	0,53
	No KT	0,47	0,40	0,40	0,27	0,07	0,07	0,00
BTR	KT	0,40	0,33	0,20	0,00	0,00	0,00	0,00
	No KT	0,73	0,60	0,60	0,47	0,20	0,07	0,00

Table 10. Impairment of common activities in the first week postoperatively

Note: Data are presented as mean, and expressed in centimeters. Abbreviations: KT, kinesio tape; PD pain drawing; Difficulty in mouth opening DMO, Difficulty in mastication DM, Difficulty in speaking DS, Difficulty in sleeping DSP, school/work days lost SW, difficulty in daily activities DA, swelled region SR, Nausea sensation NS, Bad taste BT, Analgesic A, bleeding B, skin color alteration SCA, body temperature rise BTR.

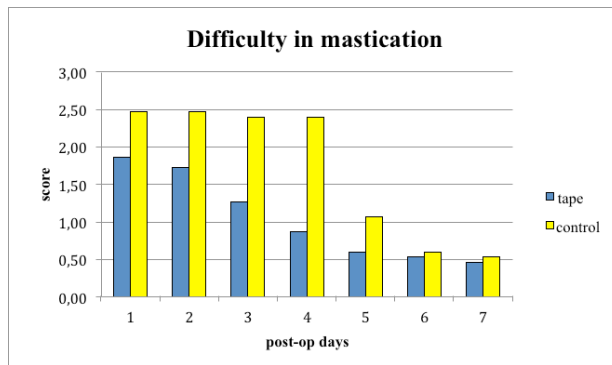


Fig. 12.

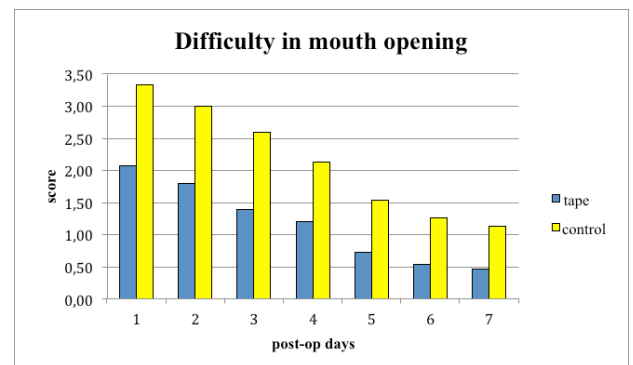


Fig. 13.

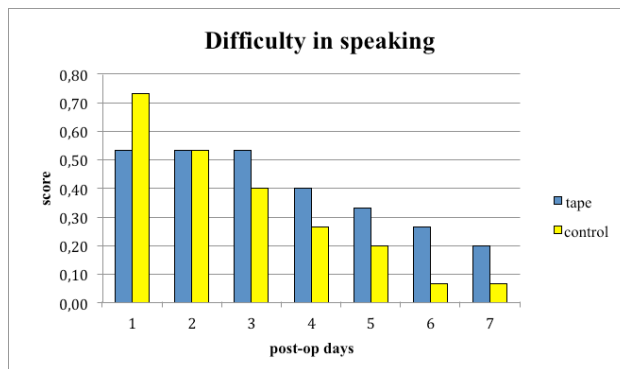


Fig. 14.

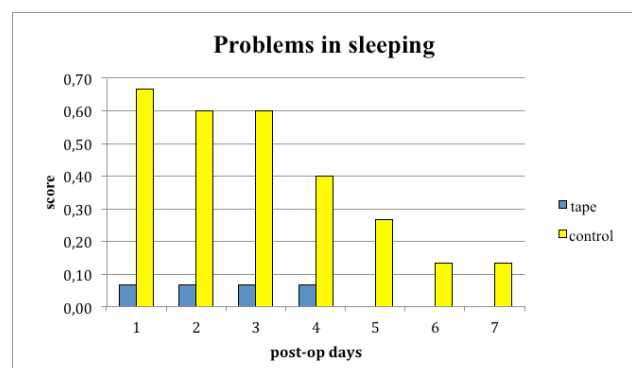


Fig. 15.

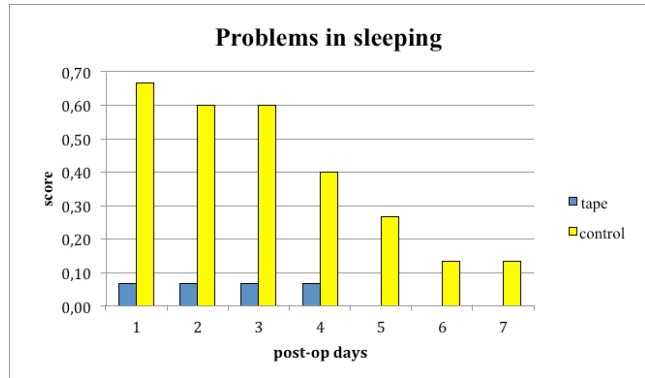


Fig. 16.

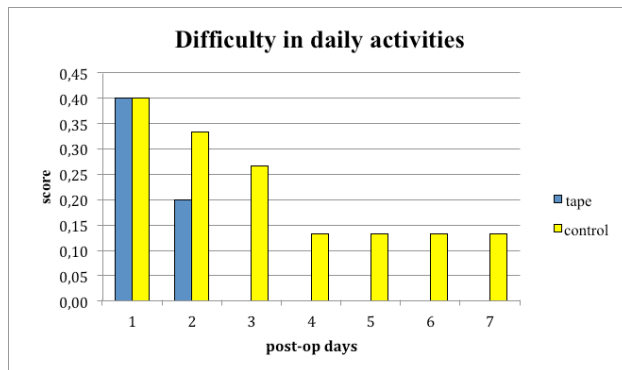


Fig. 17.

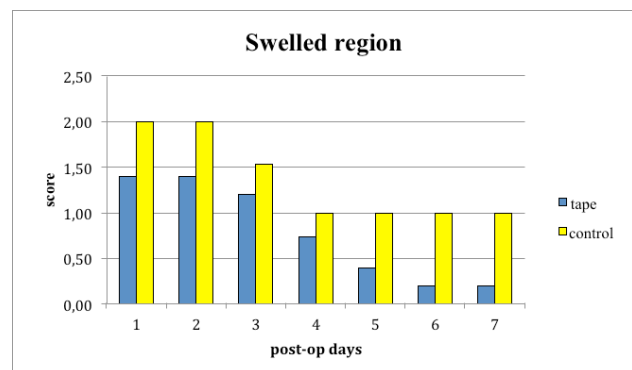


Fig. 18.

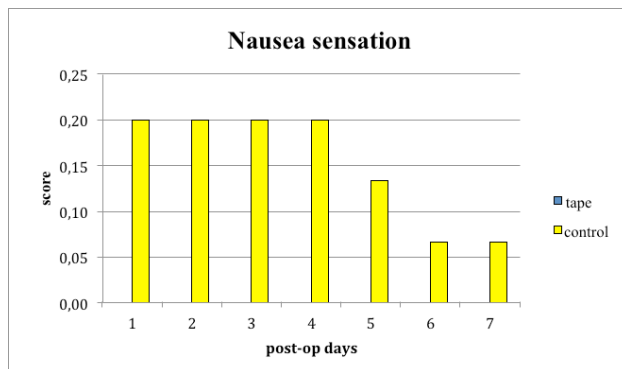


Fig. 19.

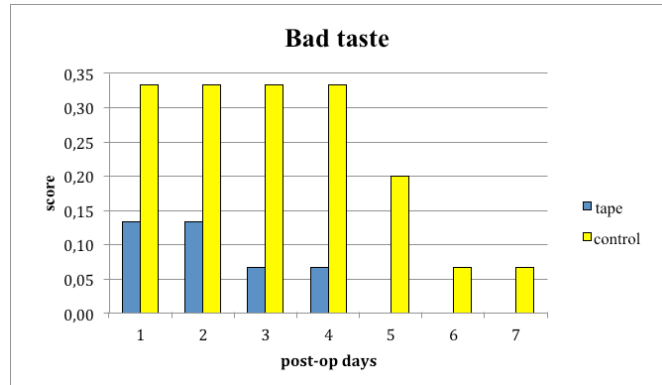


Fig. 20.

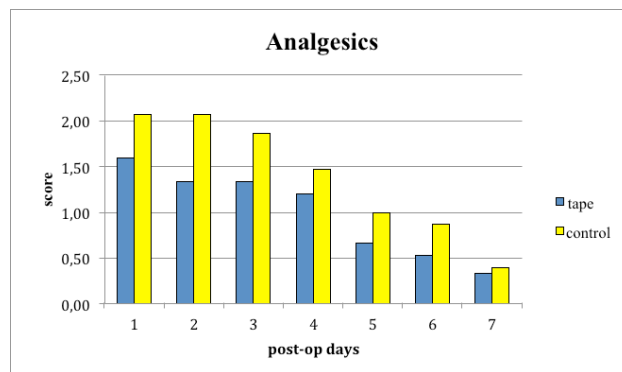


Fig. 21.

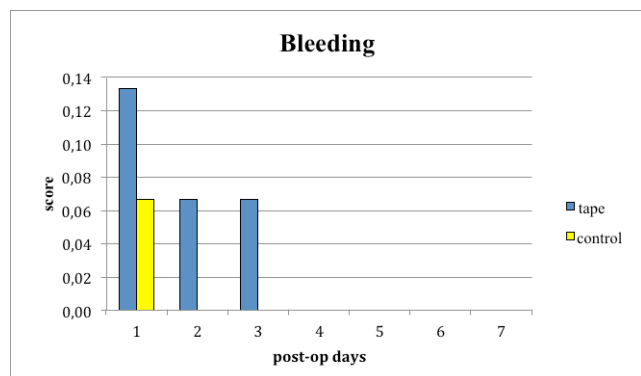


Fig. 22.

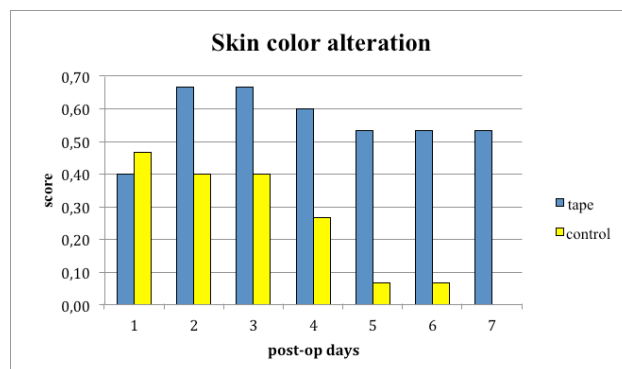


Fig. 23.

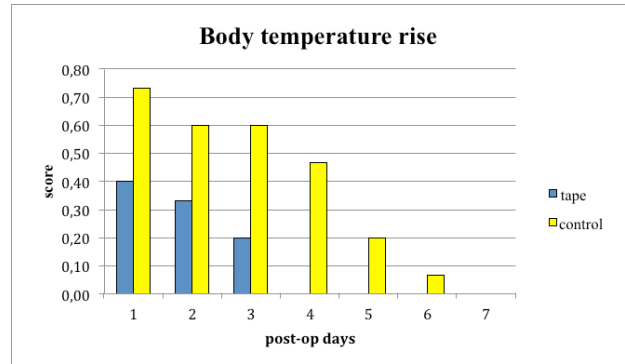


Fig. 24.

7. DISCUSSION

The purpose of this study was to examine the effects of KT application on swelling, pain, trismus, and patient satisfaction after implant surgery.

The investigators hypothesized that the use of KT would decrease the incidence of swelling and decrease turgidity within the first days after surgery, thereby decreasing pain and trismus.

Therefore, the specific aims of the study were to measure facial swelling and mouth opening, assess a pain score, and evaluate overall satisfaction and the effect of the tape on post-operative quality of life. The results of this study showed that the application of KT after implant surgery significantly lowered the incidence of swelling and decreased turgidity in the first 2 days after surgery. Although KT has no significant influence on pain control and mouth opening, patients who received KT perceived significantly lower morbidity than patients who did not (Oliwer Ristow M.D. et Al. 2013).

Postoperative morbidity after implantology is an important issue. Any means able to produce a decrease of postoperative morbidity has a subjective impact (patients' quality of life) and a social and economic impact (incapacity for work) on the patients (Oliwer Ristow M.D. et Al. 2012). To increase patients' satisfaction after surgery, it will be necessary to avoid the inconvenience associated with this procedure and minimize the subsequent side effects.

Factors affecting postoperative morbidity after implant surgery include patient factors (age, gender, ethnic background), bone-related factors (existing infection, types and grades of fracture, bone removal), and operative factors (surgical technique, surgical difficulties in implant placement and osteointegration, surgeon's experience, duration of surgery, materials).

Numerous studies have been performed on the control of postoperative edema in oral surgery. For example the use of laser in third molar surgery is painless and noninvasive, and no adverse effects appear to have been reported in patients (Osunde OD. et Al.). It is believed that laser irradiation induces an increase in the number and diameter of lymph vessels and a simultaneous decrease of blood vessel permeability. However, its use in developing countries remains limited because of the cost. Ice therapy is a simple, cheap, repeatable modality. Its therapeutic effects are due to changes in hematic flow, consequent vasoconstriction, and lowered metabolism, thereby decreasing bacterial growth. However, data concerning the effect of cryotherapy on swelling are controversial. Rana et Al., found that the use of Hilotherm (a cooling mask with permanent water flow; Hilotherm GmbH, Argenbühl-Eisenharz, Germany) was superior in the management of postoperative swelling and after treatment of Mandibular Fractures compared with conventional cooling. Unfortunately, a comparison of published drug studies represents a tremendous challenge because of the variability in parameters and methods used for each study. Many researchers have advocated the use of corticosteroids to limit postoperative complications owing to their suppressive action on transudation. Kondoh et Al. used

intraoperative corticosteroid injection into the superior joint compartment of patients with fresh condylar Mandibular Fractures.

These investigators found that the use of intraoperative corticosteroids was a more effective and quick-acting modality than conventional closed reduction with intermaxillary fixation because it increased functional recovery and control of clinical symptoms. However, few researchers have made definitive recommendations supported by randomized clinical trials. This might be due to the necessarily long administration and increased risk for potential side effects. Furthermore, many patients detest the use of steroids because they do not want to take extra medication (Markiewicz MR. et Al.). The use of nonsteroidal anti-inflammatory drug therapy has been analyzed in several studies. Topical or systemic applications to efficiently decrease pain and inflammation have been evaluated. (Aznar-Arasa et Al.). However, from the literature available, it is apparent that the combination of another drug and a nonsteroidal anti-inflammatory drug is often more effective. (Kim K. et Al.). The use of prophylactic antibiotics in oral surgery procedures is considered mandatory. However, a recent systematic review performed by Kyzas suggested that the overall evidence to support the use of prophylactic antibiotics is poor. Furthermore, emerging cases of drug allergy and drug-associated side effects are focusing more attention on alternative methods.

An initial study performed by Szolonoky et al showed that significant decreases in facial swelling and pain can be obtained by manual lymph drainage after the removal of impacted third molars (Szolnoky G. et Al.). Using reproducible facial measurements and a pain VAS, these investigators found that manual lymph drainage promotes an improvement of lymph circulation. Using this technique might be beneficial for postoperative treatment after head and neck surgery; however, it is associated with substantial physical effort and high costs.

Taping has long been used for the prevention and treatment of sport injuries to provide protection and support to the joint or muscle during movement. Despite the increased use of KT in clinical practice, there is limited research-based evidence to support the use of KT (Williams S. et Al.). KT has a potential influence on the decrease of swelling and hemorrhage, but studies have concentrated on the treatment of neoplastic or cancer-related lymphedemas, without evidence-based significance (Chou YH. et Al., Tsai HJ. et Al.).

To the authors' knowledge, clinical studies using KT for postoperative management of swelling, pain, and trismus after implant surgery have not yet been performed. The present results showed that the application of KT after implant surgery has a significant influence on tissue reaction and swelling, with an average cost for unilateral taping lower than 1 euro for patient.

In the present study KT group displayed a lower post-operative pain suggesting that the tape has an analgesic effect. Other studies that used KT for controlling post-operative pain in oral surgery procedure did not find similar results. Indeed, some investigators have claimed that KT can decrease pain by decreasing pressure on nociceptors.

Patients' mouth opening increased faster after surgery in the KT group than in the no-KT group. This might be due to the fact that swelling receded faster, thus lessening skin tension. Furthermore, the KT effect lessens pain and perception. Movement stresses the KT; it adjusts its length to that of the skin only to an extent and thus deforms the skin. This constant impulse stimulates the skin and diverts patients' perceptions. These results are reflected in the subjective findings. Patients in the KT group reported greater satisfaction after surgery compared with those in the no-KT group. Furthermore, the patients' sensation of swelling was lower in the KT group than in the no-KT group. However, the present study design was not suitable to exclude the possible placebo effects caused by the KT. The primary endpoint, increase of swelling, was significantly lower for the KT group than the no-KT group. After surgery, maximum swelling usually occurs 2 to 3 days after surgery, which is in accord with the results of the present control group. Furthermore, the decrease in swelling was faster in the KT group than in the no-KT group, with turgidity decreasing significantly during the first 2 days after surgery.

This observation might be due to the unique properties of KT that allow it to structurally lift the skin and open the superficial lymphatic pathways of the affected area. KT is claimed to stretch 120% to 140% of its original length and subsequently recoil to its original length after application, thus exerting a proposed pulling force to the skin that forms convolutions below the taped area. Although friction, depending on the elasticity of the tape, can irritate the skin and some adhesives might produce an allergic reaction in some patients, there was no incidence of adverse reactions in the present study. However, adverse reactions should be considered for different tape types depending on the acrylic adhesive used by the manufacturer. To the best of the authors' knowledge, there have been no reported cases of severe allergic reaction to the KT (Kenzo K. et Al.).

In the present study we did not exert extreme tension on the facial tissue to avoid excessive discomfort to patient, to preserve the most delicate facial skin.

Assessment of decreased facial volume is one of the greatest obstacles for a reliable and objective demonstration of a used method. Although numerous methods have been tried, most are imprecise, complex, expensive, or difficult to standardize.³⁶⁻³⁸ In the present study we tried to quantify changes in facial volume using a method of linear measurements, applying a series of data points, and using defined landmarks covering the entire facial area of interest. When marking the segment endpoints, great care was taken to always measure the same distances.

The use of KT appears promising, because it is simple to carry out, less traumatic, and economical; can be performed everywhere in the world; and is free from side effects to the system. Furthermore, even when swelling persists, KT provides an impression of minor swelling that distracts patients from their pain and morbidity.

In conclusion, overall positive results were found in the patients using KT, that might be recommended as an alternative means to control post-operative discomfort after oral surgery procedures.

8. CONCLUSION

The use of KT appears promising, because it is simple to carry out, less traumatic, economical, can be performed everywhere in the world, free from side effects on the body. Even when swelling persists, KT gives patients the impression of a minor swelling detracting them from their pain and morbidity. Further studies have to be performed to find out if KT can reduce or replace the need for additional medications such as the use of steroids or analgesics.

ATTACHMENT 1

SCHEDA VALUTAZIONE PAZIENTI

Paziente n. _____	Intervento _____
Nome _____	Cognome _____
Data di nascita _____	Sesso F <input type="checkbox"/> M <input type="checkbox"/>

QUESTIONARIO SULLA QUALITÀ DELLA VITA:

Si prega di indicare con un ✓ in ogni casella un numero da 0 a 5 secondo la scala:

0 = per nulla, 1= pochissimo, 2=poco, 3 = abbastanza, 4 = molto, 5 = moltissimo

<u>Giorno</u>	1	2	3	4	5	6	7
Ha avuto difficoltà nell'aprire la bocca?							
Ha avuto difficoltà nella masticazione?							
Ha avuto difficoltà a parlare?							
Ha avuto problemi a dormire?							
Ha perso giorni di lavoro/scuola?							
Ha avuto qualche difficoltà nello svolgere le sue attività quotidiane?							
La regione trattata è gonfia?							
Ha provato senso di nausea?							
Ha provato una sensazione di cattivo sapore?							
Ha assunto antidolorifici?							
C'è sanguinamento nella regione trattata?							
Ci sono alterazioni nel colore della cute?							
C'è stato un rialzo della temperatura corporea?							

VISUAL ANALOGUE SCALE

**Sente dolore a livello della regione trattata?
(mettere un segno sulla linea da 0 a 10)**

GIORNO 1: (per nulla) 0 (moltissimo) 10

0	1	2	3	4	5	6	7	8	9	10

GIORNO 2: (per nulla) 0 (moltissimo) 10

0	1	2	3	4	5	6	7	8	9	10

GIORNO 3: (per nulla) 0 (moltissimo) 10

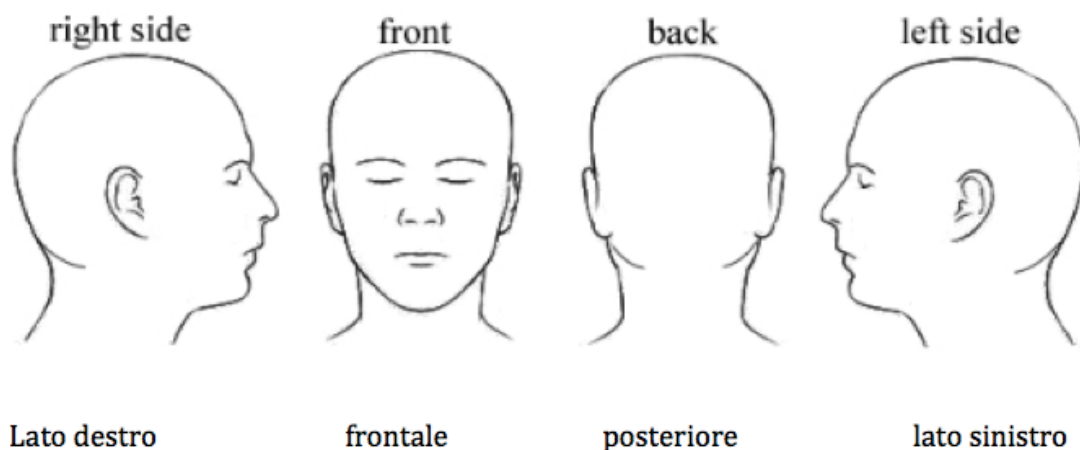
0	1	2	3	4	5	6	7	8	9	10

Ha avuto problemi a mostrarsi in pubblico con il tape in volto? (barrare con una crocetta, ✕ la risposta desiderata) ☐ SÌ o ☐ NO

ATTACHMENT 2

COMPILAZIONE PAIN DRAWING

A cura del paziente



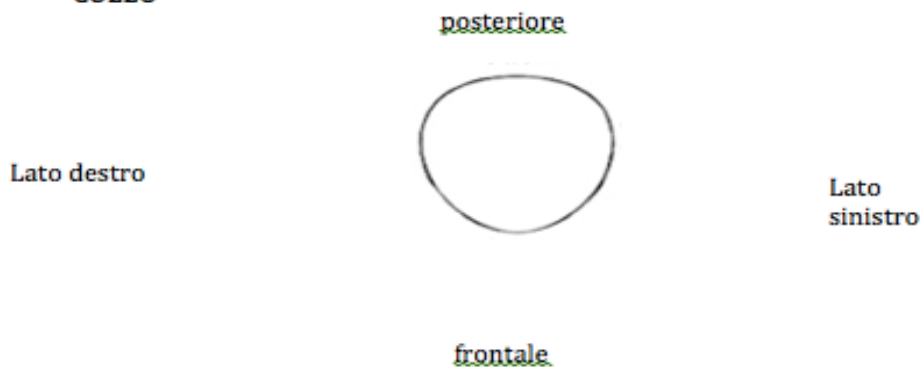
Il paziente è pregato di segnare sul disegno con la penna i punti o le aree in cui si sente dolore alla testa e/o al collo.

In caso di dolore all'interno della testa più profondo segnare da quale lato si sente.

In caso di dolori differenti per tipologia e localizzazione segnare con tratti diversi. A seguito alcuni esempi.



COLLO



ATTACHMENT 3:

VALUTAZIONE

Valutazione apertura buccale

Misurare il valore del massimo dell'apertura bocca con un righello millimetrico.

Valutazione edema facciale:

Metodo Laskin, comporta l'esecuzione di tre misurazioni di valutazione (pre-intervento, a 24 ore, a 48 ore).

- 1) Misurazione prima dell'intervento chirurgico,
- 2) Misurazione a 24 ore dall'intervento chirurgico
- 3) Misurazione a 48 ore dall'intervento chirurgico

Le misure vengono effettuate tra i punti di interesse:

- (a) Distanza in centimetri dal bordo inferiore del lobo dell'orecchio al punto medio del mento denominato: **DISTANZA ORIZZONTALE alla SINFISI (DHS).**



DHS horizontal distance to the symphysis

Distanza in centimetri dal bordo inferiore del lobo dell'orecchio - al punto medio della protuberanza mentoniera, denominata: distanza orizzontale alla sinfisi

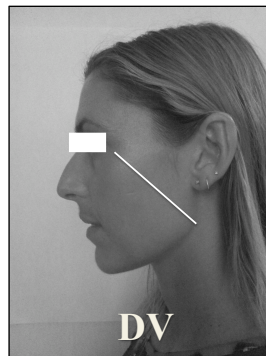
- (b) Distanza in centimetri dal bordo inferiore del lobo all'angolo esterno della bocca, denominato: **DISTANZA ORIZZONTALE (DHC).**



DHC horizontal distance to the symphysis

Distanza in centimetri dal bordo inferiore del lobo - all'angolo esterno della bocca, denominata: distanza orizzontale

- (c) La distanza in centimetri dall'angolo palpebrale esterno all'angolo mandibolare, denominato: **DISTANZA VERTICALE (DV).**



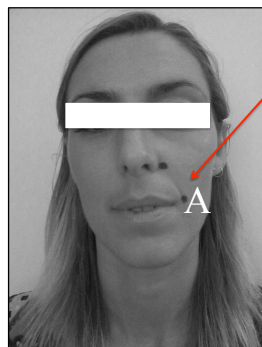
DV horizontal distance to the symphysis

Distanza in centimetri dall'angolo palpebrale esterno - all'angolo mandibolare, denominata: distanza verticale

PUNTI DI REPERE POSIZIONAMENTO KINESIOTAPE:

A. Angolo buccale

Angolo formato lateralmente dal labbro superiore e dal labbro inferiore

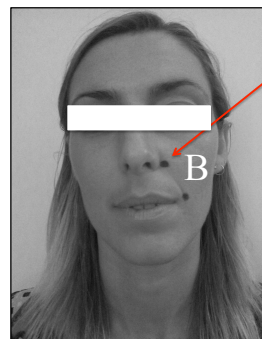


A. Angolo buccale

Angolo formato lateralmente dal labbro superiore e dal labbro inferiore

B. Piega nasolabiale

Piega cutanea che si estende dal naso all'angolo della bocca

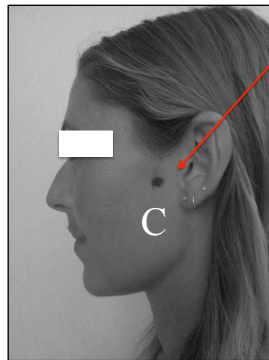


B. Piega nasolabiale

Piega cutanea che si estende dall'angolo del naso all'angolo della bocca

C. Articolazione temporo-mandibolare

Può essere palpata anteriormente al trago dell'orecchio esterno mentre la bocca viene aperta e chiusa



C. Articolazione temporo-mandibolare

Può essere palpata anteriormente al trago dell'orecchio esterno mentre la bocca viene aperta e chiusa

D. Protuberanza mentoniera

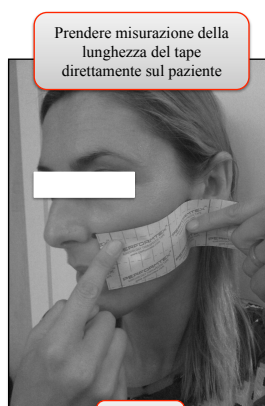
Parte centrale simmetrica



D. Protuberanza mentoniera

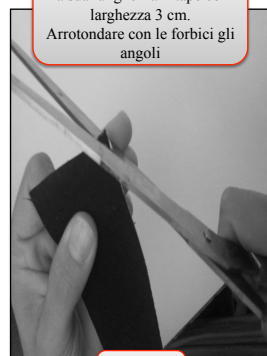
Parte centrale simmetrica

APPLICAZIONE KINESIO TAPING



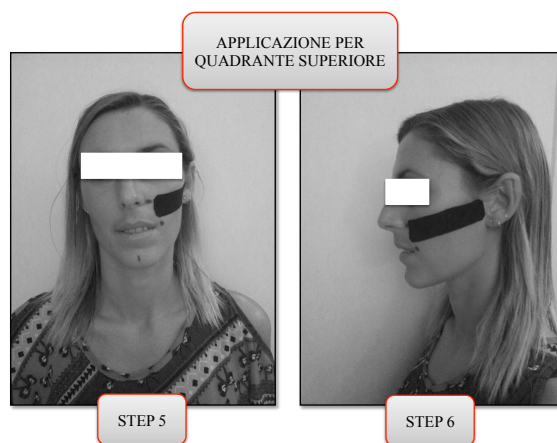
Prendere misurazione della lunghezza del tape direttamente sul paziente

STEP 1



Tagliare in due parti per tutta la sua lunghezza il tape con larghezza 3 cm. Arrotondare con le forbici gli angoli

STEP 2



- A. Eseguire entrambe le applicazioni come da sequenza per entrambi i quadranti**
B. Evitare sovrapposizioni dei lembi del tape.

REFERENCES

- Berglundh, T.; Persson, L.; Klinge, B. (2002). "A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years". *Journal of clinical periodontology* 29 (Suppl 3): 197–212.
- Pjetursson, B. E.; Thoma, D.; Jung, R.; Zwahlen, M.; Zembic, A. (2012). "A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years". *Clinical Oral Implants Research* 23: 22–38.
- Papaspolidakos, P.; Mokti, M.; Chen, C. J.; Benic, G. I.; Gallucci, G. O.; Chronopoulos, V (Jan 2013). "Implant and Prosthodontic Survival Rates with Implant Fixed Complete Dental Prostheses in the Edentulous Mandible after at Least 5 Years: A Systematic Review". *Clinical Implant Dentistry and Related Research*.
- Maxim Goldman. Titanium surfaces with nanostructures influence on osteoblasts proliferation: a systematic review. *J Oral Maxillofac Res*. 2014 Jul-Sep;4:(3).
- Schmidt-Hoberg W, Luhr HG. Technic and results of functional early treatment of collum fractures associated with mandibular-body fractures. *Fortschr Kiefer Gesichtschir* 1976;21: 317.
- Luhr HG. Vitallium Luhr systems for reconstructive surgery of the facial skeleton. *Otolaryngol Clin North Am* 1987;20:573.
- Jemt T. Single implants in the anterior maxilla after 15 years of follow-up: comparison with central implants in the edentulous maxilla. *Int J Prosthodont*. 2008 Sep-Oct;21(5):400-8.
- Oliver Ristow, MD. Does Elastic Therapeutic tape reduce Postoperative swelling, pain, and trismus after open reduction and internal fixation of mandibular fractures? *American Association of Oral and Maxillofacial Surgeons*. 2013.
- Satomi K, Akagawa Y, Nikai H, Tsuru H. Bone implant interface structures after nontapping and tapping insertion of screw-type titanium alloy endosseous implants. *J Prosthet Dent*. 1988 Mar;59(3):339-42.
- Schmidt C, Kaspar D, Sarkar MR, Claes LE, Ignatius AA. A scanning electron microscopy study of human osteoblast morphology on five orthopedic metals. *J Biomed Mater Res*. 2002;63(3):252-61.
- Calderoni DR, Guidi Mde C, Kharmandayan P, Nunes PH: Seven-year institutional experience in the surgical treatment of orbito-zygomatic fractures. *J Craniomaxillofac Surg*. 2011;39: 593e599.
- Kim K, Brar P, Jakubowski J, Kaltman S, Lopez E, The use of corticosteroids and nonsteroidal antiinflammatory medication for the management of pain and inflammation after third molar surgery: a review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2009; 107(5):630–640.
- Aznar-Arasa L., Figueiredo R, Gay-Escoda C. Iatrogenic displacement of lower third molar roots into the sublingual space: report of 6 cases. *J Oral Maxillofac Surg*. 2012 Feb;70(2):e107-15.
- De Sousa Santos JA1, da Silva LC, de Santana Santos T, Menezes Júnior LR, de Assunção Oliveira AC, Brandão JR. Comparative study of tramadol combined with dexamethasone and diclofenac sodium in third-molar surgery. *J Craniomaxillofac Surg*. 2012 Dec;40(8):694-700.
- Oliver Ristow, Bettina Hohlweg-Majert, Stephen R. Stürzenbaum, Therapeutic elastic tape reduces morbidity after wisdom teeth removal—a clinical trial. *Clin Oral Invest*. 2014;18:1205–1212.
- Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. *Sports Med*. 2012;42(2):153–164.
- Morris D1, Jones D, Ryan H, Ryan CG. The clinical effects of Kinesio® Tex taping: A systematic review. *Physiother Theory Pract*. 2013 May;29(4):259-70.
- Kase K, Wallis J, Kase T (2003) *Clinical therapeutic applications of the kinesio taping method*, 2nd edn. Kinesio Taping Association, Tokyo.
- Kase K, Stockheimer KR (2006) *Kinesio taping for lymphoedema and chronic swelling—Kinesio Taping Manual*. Ken Ikai Co. Ltd., Tokyo, pp 1–172.
- Lekholm U, Gröndahl K, Jemt T. Outcome of oral implant treatment in partially edentulous jaws followed 20 years in clinical function. *Clin Implant Dent Relat Res*. 8(4):178-86;2016.
- Juodzbals G, Wang HL, Sabalys G. Injury of the Inferior Alveolar Nerve during Implant Placement: a Literature Review. *J Oral Maxillofac Res*. 2011 Apr 1;2(1):e1.
- Shavit I, Juodzbals G. Inferior alveolar nerve injuries following implant placement - importance of early diagnosis and treatment: a systematic review. *J Oral Maxillofac Res*. 2014 Dec 29;5(4):e2.

- Mokti, M.; Chen, C. J.; Benic, G. I.; Gallucci, G. O.; Chronopoulos, "Implant and Prosthodontic Survival Rates with Implant Fixed Complete Dental Prostheses in the Edentulous Mandible after at Least 5 Years: A Systematic Review". *Clinical Implant Dentistry and Related Research*. (Jan 2013).
- Berglundh, T.; Persson, L.; Klinge, B. (2002). "A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years". *Journal of clinical periodontology* 29 (Suppl 3): 197–212.
- Pjetursson, B. E.; Thoma, D.; Jung, R.; Zwahlen, M.; Zembic, A. (2012). "A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years". *Clinical Oral Implants Research* 23: 22–38.
- Bozini, T.; Petridis, H.; Garefis, K.; Garefis, P. (2011). "A meta-analysis of prosthodontic complication rates of implant-supported fixed dental prostheses in edentulous patients after an observation period of at least 5 years". *The International journal of oral & maxillofacial implants* 26 (2): 304–318.
- Misch, Carl E (2007). *Contemporary Implant Dentistry*. St. Louis, Missouri: Mosby Elsevier.
- Branemark, Per-Ingvar; Zarb, George (1989). *Tissue-integrated prostheses (in English)*. Berlin, German: Quintessence Books. ISBN 0867151293.
- Markus Schlee, Jan-Friedrich Dehner, Katja Baukloh, Arndt Happe, Oliver Seitz and Robert Sader. *Esthetic outcome of implant-based reconstructions in augmented bone: comparison of autologous and allogeneic bone block grafting with the pink esthetic score (PES)*. *Head & Face Medicine* 2014, 10:21.
- Jokstad, Asbjorn, ed. (2009). *Osseointegration and Dental Implants (in English)*. John Wiley & Sons. ISBN 9780813804743.
- Col S.K. Rath, Brig Ramen Sinha, Col Derek D'Souza. *Evolving surgical prosthetic rehabilitation protocol for success of dental implant placed in distracted alveolar ridge*. *medical journal armed forces india* 70 (2014) 364e370.
- Sinn, D. P., Bedrossian, E., Vest, A. K. (2011). "Craniofacial Implant Surgery". *Oral and Maxillofacial Surgery Clinics of North America* 23 (2): 321–335.
- Chen, Y.; Kyung, H. M.; Zhao, W. T.; Yu, W. J. (2009). "Critical factors for the success of orthodontic mini-implants: A systematic review". *American Journal of Orthodontics and Dentofacial Orthopedics* 135 (3): 284–291.
- Lee, SL (2007). *Applications of orthodontic mini implants*. Hanover Park, IL: Quintessence Publishing Co, Inc. pp. 1–11.
- Ruggiero, S. L.; Dodson, T. B.; Assael, L. A.; Landesberg, R.; Marx, R. E.; Mehrotra, B. (2009). "American Association of Oral and Maxillofacial Surgeons Position Paper on Bisphosphonate-Related Osteonecrosis of the Jaws—2009 Update". *J Oral and Maxillofac Surg* 67 (5): 2–12.
- Webster TJ, Schadler LS, Siegel RW, Bizios R. Mechanisms of enhanced osteoblast adhesion on nanophase alumina involve vitronectin. *Tissue Eng*. 2001 Jun;7(3):291-301.
- Webster TJ, Eijiofor JU. Increased osteoblast adhesion on nanophase metals: Ti, Ti6Al4V, and CoCrMo. *Biomaterials*. 2004 Aug;25(19):4731-9.
- Mavrogenis AF, Dimitriou R, Parvizi J, Babis GC. Biology of implantosseointegration. *J Musculoskelet Neuronal Interact*. 2009 Apr-Jun;9(2):61-71. Review.
- Le Guéhennec L, Soueidan A, Layrolle P, Amouriq Y. Surface treatments of titanium dental implants for rapid osseointegration. *Dent Mater*. 2007 Jul;23(7):844-54. Epub 2006 Aug 14. Review.
- Nanci A, Wuest JD, Peru L, brunet P, Sharma V, ZalzalS, McKee MD. Chemical modification of titanium surfaces for covalent attachment of biological molecules. *J Biomed Mater Res*. 1998 May; 40(2):324-35.
- Piattelli A, Piattelli M, Romasco N, Trisi P. Histochemical and laser scanning microscopy characterization of the hydroxyapatite-bone interface: an experimental study in rabbits. *Int J Oral Maxillofac Implants*. 1994 Mar-Apr;9(2):163-8.
- Kumar, M. N.; Honne, T. (2012). "Survival of dental implants in bisphosphonate users versus non-users: A systematic review". *The European journal of prosthodontics and restorative dentistry* 20 (4): 159–162.
- Branemark, Per-Ingvar Worthington, Philip, ed (1992). *Advanced osseointegration surgery: applications in the maxillofacial region (in english)*. Carol Stream, Illinois: Quintessence Books. ISBN 0867152427.
- Pallaci, Patrick (1995). *Optimal implant positioning and soft tissue management for the Branemark system (in english)*. Germany: Quintessence Books. pp. 21–33. ISBN 0867153083.
- "Guidance for Industry and FDA Staff - Class II Special Controls Guidance Document: Root-form Endosseous Dental Implants and Endosseous Dental Abutments". FDA. 2004-05-12. Retrieved 2013-11-11.

Esposito M, Coulthard P, Oliver R, Thomsen P, Worthington HV. Antibiotics to prevent complications following dental implant treatment. *Cochrane Database Syst Rev* 2003;(3): CD004152. Update in: *Cochrane Database Syst Rev* 2008; (3).

Atieh, M. A.; Ibrahim, H. M.; Atieh, A. H. (2010). "Platform Switching for Marginal Bone Preservation Around Dental Implants: A Systematic Review and Meta-Analysis". *Journal of Periodontology* 81 (10): 1350–66.

Anthony (2003). *Soft tissue and esthetic considerations in implant dentistry* (in english). Carol Stream, IL: Quintessence Books. ISBN 0867153547.

Newman, Michael; Takei, Henry; Klokkevold, Perry, eds. (2012). *Carranza's Clinical Periodontology* (in English). St. Louis, Missouri: Elsevier Saunders. ISBN 9781437704167.

Patzelt, S. B. M.; Bahat, O.; Reynolds, M. A.; Strub, J. R. (2013). "The All-on-Four Treatment Concept: A Systematic Review". *Clinical Implant Dentistry and Related Research*.

Assunção, W. G. A.; Barão, V. A. R.; Delben, J. A.; Gomes, É. A.; Tabata, L. F. (2009). "A comparison of patient satisfaction between treatment with conventional complete dentures and overdentures in the elderly: A literature review". *Gerodontology* 27 (2): 154–162.

Lee, J. Y.; Kim, H. Y.; Shin, S. W.; Bryant, S. R. (2012). "Number of implants for mandibular implant overdentures: A systematic review". *The Journal of Advanced Prosthodontics* 4 (4): 204–9.

Ferguson, M (May 23, 2014). "Rhinosinusitis in oral medicine and dentistry.". *Australian dental journal* 59 (3): 289–95.

Papaspyridakos, P.; Chen, C. - J.; Singh, M.; Weber, H. - P.; Gallucci, G. O. (2011). "Success Criteria in Implant Dentistry: A Systematic Review". *Journal of Dental Research* 91 (3): 242–248.

Javed, F.; Romanos, G. E. (2010). "The role of primary stability for successful immediate loading of dental implants. A literature review". *Journal of Dentistry* 38 (8): 612–620.

Renouard, Frank (1999). *Risk Factors in Implant Dentistry: Simplified Clinical Analysis for Predictable Treatment*. Paris, France: Quintessence International. ISBN 0867153555.

De Brandão, M. L.; Vettore, M. V.; Vidigal Júnior, G. M. (2013). "Peri-implant bone loss in cement- and screw-retained prostheses: Systematic review and meta-analysis". *Journal of Clinical Periodontology* 40 (3): 287–295.

Gk Thakral, Rashmi thakral Neeeraj Sharma, Jyotsana seth, Pallavi Vashisht. Reviews articles.Nanosurface – The Future of Implants, *Journal of Clinical and Diagnostic Research*. 2014 May, Vol-8(5): ZE07-ZE10.

Jung, R. E.; Pjetursson, B. E.; Glauser, R.; Zembic, A.; Zwahlen, M.; Lang, N. P. (2008). "A systematic review of the 5-year survival and complication rates of implant-supported single crowns". *Clinical Oral Implants Research* 19 (2): 119–130.

Goodacre, C. J.; Bernal, G.; Rungcharassaeng, K.; Kan, J. Y. K. (2003). "Clinical complications with implants and implant prostheses". *The Journal of Prosthetic Dentistry* 90 (2): 121–132.

Esposito, M.; Murray-Curtis, L.; Grusovin, M. G.; Coulthard, P.; Worthington, H. V. (2007). "Interventions for replacing missing teeth: different types of dental implants". *Cochrane Database of Systematic Reviews*.

Esposito, M.; Worthington, H. V. (2013). "Interventions for replacing missing teeth: dental implants in zygomatic bone for the rehabilitation of the severely deficient edentulous maxilla". *Cochrane Database of Systematic Reviews* (Cochrane Database of Systematic Reviews).

Reza, M (2007). *Nanomaterials and Nanosystems for Biomedical Applications [Mozafari]* (in English). SpringerLink: Springer e-Books. ISBN 9781402062896.

Guo, Cecilia Yan; Matinlinna, Jukka Pekka; Tang, Alexander Tin Hong (2012). "Effects of Surface Charges on Dental Implants: Past, Present, and Future". *International Journal of Biomaterials* 2012: 1–5.

Tomisa AP, Launey ME, Lee JS, Mankani MH, Wegst UG, Saiz E. Nanotechnology approaches to improve dental implants. *Int J Oral Maxillofac Implants*. 2011;26 Suppl:25-44; discussion 45-9.

Del Fabbro M.; Corbella S.; Ceresoli V.; Ceci C.; Taschieri S. Plasma Rich in Growth Factors Improves Patients' Postoperative Quality of Life in Maxillary Sinus Floor Augmentation: Preliminary Results of a Randomized Clinical Study. 2013 Wiley Periodicals, Inc. *Clinical Implant Dentistry and Related Research*, Volume , Number, 2013.

David M. Dohan Ehrenfest, Isabel Andia, Matthias, A. Zumstein, Chang-Qing Zhang, Nelson R. Pinto, Tomasz Bielecki. Review article. Classification of platelet concentrates (Platelet-Rich Plasma-PRP, Platelet-Rich Fibrin-PRF) for topical and infiltrative use in orthopedic and sports medicine: current consensus, clinical implications and perspectives. *Muscles, Ligaments and Tendons Journal* 2014; 4 (1): 3-9.

Bielecki T, Dohan Ehrenfest DM. Platelet-rich plasma (PRP) and Platelet-Rich Fibrin (PRF): surgical adjuvants, preparations for in situ regenerative medicine and tools for tissue engineering. *Curr Pharm Biotechnol*. 2012;13:1121-1130.

Kavita Hotwani, Krishna Sharma. Platelet rich fibrin-a novel acumen into regenerative endodontic therapy, Review article The Korean Academy of Conservative Dentistry. August 19, 2013;

Del Fabbro M., Ceresoli V., Lolato A., Taschieri S. Effect of Platelet Concentrate on Quality of Life after Periradicular Surgery: A Randomized Clinical Study. *J Endod* 2012;38:733–739.

M. Marrelli, M. Tatullo. Influence of PRF in the healing of bone and gingival tissues. Clinical and histological evaluations. *European Review for Medical and Pharmacological Sciences*. 2013;17:1958-1962.

Mozzati M, Gallesio G, Russo A, Staiti G, Mortellaro C. Third-molar extraction with ultrasound bone surgery: a case-control study. *J Craniofac Surg*. 2014 May;25(3):856-9.

Jordi Cascos-Romero, Eduardo Vázquez-Delgado, Eduardo Vázquez-Rodríguez, Cosme Gay-Escoda. The use of tricyclic antidepressants in the treatment of temporomandibular joint disorders: Systematic review of the literature of the last 20 years *Med Oral Patol Oral Cir Bucal*. 2009 Jan 1;14 (1):E3-7.

Kim K, Brar P, Jakubowski J, et al: The use of corticosteroids and nonsteroidal antiinflammatory medication for the management of pain and inflammation after third molar surgery: A review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol. Endod* 107:630, 2009.

Von Arx T, Jensen SS, Hänni S, Schenk RK. Haemostatic agents used in periradicular surgery: an experimental study of their efficacy and tissue reactions. *Int Endod J*. 2006;39:800-8.

Rieko Takemae, Takamoto Uemur, Hiroteru Okamoto, Tomoko Matsui, Masao Yoshida, Shinji Fukazawa, Kosuke Tsuchida, Koji Teruya, Tooru Tsunoda Changes in mental health and quality of life with dental implants as evaluated by General Health Questionnaire (GHQ) and Health Utilities Index (HUI) *Environ Health Prev Med* (2012) 17:463–473.

M. Del Fabbro, S. Taschieri & R. Weinstein Quality of life after microscopic periradicular surgery using two different incision techniques: a randomized clinical study Received 15 September 2008; accepted 1 December 2008 *International Endodontic Journal*, 42, 360–367, 2009.

Seferli J, Michelin M, Klinge B, Wettergren L. Patients' experiences of dental implant placement for treatment of partial edentulism in a student clinic setting. *Swed Dent J*. 2014;38(2):77-85.

Byers MR. Dental sensory receptors. *Int. Rev. Neurobiol.* 1984; 25: 39–94. This is a review paper describing the structure of the dental innervation. The morphology of both pulpal and periodontal nerves and receptors is presented and discussed in relation to the functional aspects.

Byers MR, Närhi M. Dental injury models: experimental tools for understanding neuroinflammatory interactions and polymodal nociceptor function. *Crit. Rev. Oral Biol. Med.* 1999; 10: 4–39.

Jyväsjarvi E, Kniffki K-D. Cold stimulation of teeth: a comparison between the responses of cat intradental A and C fibres and human sensation. *J. Physiol.* 1987; 391: 193–207.

Mumford JM, Bowsher D. Pain and prothopatic sensibility. A review with particular reference to teeth. *Pain* 1976; 2: 223–43.

Närhi M, Jyväsjarvi E, Virtanen A, Huopaniemi T, Ngassapa D, Hirvonen T. Role of intradental A- and C-type nerve fibres in dental pain mechanisms. *Proc. Finn. Dent. Soc.* 1992; 88 (Suppl. 1): 507–16.

Matthews B, Baxter J, Watts S. Sensory and reflex responses to tooth pulp stimulation in man. *Brain Res.* 1976; 113: 83–94.

Olgart L, Gazelius B, Sundström F. Intradental nerve activity and jaw-opening reflex in response to mechanical deformation of cat teeth. *Acta Physiol. Scand.* 1988; 133: 399–406.

Haug SR, Heyeraas KJ. Modulation of dental inflammation by the sympathetic nervous system. *J. Dent. Res.* 2006; 85: 488–95.

Shimeno Y, Sugawara Y, Iikubo M, Shoji N, Sasano T. Sympathetic nerve fibers sprout into rat odontoblast layer but not into dentinal tubules in response to cavity preparation. *Neurosci. Lett.* 2008; 435: 73–7.

Guyton AC, Hall JE. *Textbook of Medical Physiology*. Philadelphia, PA: Elsevier–Saunders, 2006.

Hirvonen TJ. A quantitative electron-microscopic analysis of the axons at the apex of the canine tooth pulp in the dog. *Acta Anat.* 1987; 128: 134–9.

Holland GR, Robinson PP. The number and size of axons at the apex of the cat's canine tooth. *Anat. Rec.* 1983; 205: 215–22.

Närhi MVO. The characteristics of intradental sensory units and their responses to stimulation. *J. Dent. Res.* 1985; 64: 564–71.

Närhi M, Jyväsjarvi E, Virtanen A, Huopaniemi T, Ngassapa D, Hirvonen T. Role of intradental A- and C-type nerve fibres in dental pain mechanisms. *Proc. Finn. Dent. Soc.* 1992; 88 (Suppl. 1): 507–16.

Byers MR. Neuropeptide immunoreactivity in dental sensory nerves: variation related to primary odontoblast function and survival. In: *Dentine/Pulp Complex* (Shimono M, Maeda T, Suda H, Takahashi K, eds). Tokyo: Quintessence, 1996; 124–9.

- Olgart L. Neural control of pulpal blood flow. *Crit. Rev. Oral Biol. Med.* 1996; 7: 159–71.
- Byers MR, Taylor PE. Effect of sensory denervation on the response of rat molar pulp to exposure injury. *J. Dent. Res.* 1993; 72: 613–18.
- Cereceda F.A, Henke H, Lundberg JM, Petermann JB, Hökfelt T, Fischer JA. Calcitonin gene-related peptide (CGRP) in capsaicin-sensitive substance P-immunoreactive sensory neurons in animals and man: distribution and release by capsaicin. *Peptides* 1987; 8: 399–410.
- Lundberg JM. Peptidergic control of the autonomic regulation system in the orofacial region. *Proc. Finn. Dent. Soc.* 1989; 85: 239–50.
- Olgart L. Neurogenic components of pulp inflammation. In: *Dentine/Pulp Complex* (Shimono M, Maeda T, Suda H, Takahashi K, eds). Tokyo: Quintessence Publishing, 1996; 169–75.
- Holland GR. Odontoblasts and nerves; just friends. *Proc. Finn. Dent. Soc.* 1986; 82: 179–89.
- Lilja J. Sensory differences between crown and root dentin in human teeth. *Acta Odontol. Scand.* 1980; 38: 285–91.
- Närhi M, Yamamoto H, Ngassapa D. Function of intradental nociceptors in normal and inflamed teeth. In: *Dentine/ Pulp Complex* (Shimono M, Maeda T, Suda H, Takahashi K, eds). Tokyo: Quintessence Publishing, 1996; 136–40.
- Brännström M. A hydrodynamic mechanism in the transmission of pain-producing stimuli through the dentine. In: *Sensory Mechanisms in Dentine* (Anderson DJ, ed.). Oxford: Pergamon Press, 1963; 73–9.
- Brännström M. *Dentine and Pulp in Restorative Dentistry*. Nacka, Sweden: Dental Therapeutics AB, 1981.
- Hirvonen T, Närhi M. The effect of dentinal stimulation on pulp nerve function and pulp morphology in the dog. *J. Dent. Res.* 1986; 65: 1290–3.
- Lilja J, Nordenvall K-J, Brännström M. Dentine sensitivity, odontoblasts and nerves under desiccated or infected experimental cavities. *Swed. Dent. J.* 1982; 6: 93–103.
- El Karim IA, Lamey PJ, Linden GJ, Awawadeh LA, Lundy FT. Caries-induced changes in the expression of pulpal neuropeptide Y. *Eur. J. Oral Sci.* 2006; 114: 133–7.
- Gibbs JL, Hargreaves KM. Neuropeptide Y Y1 receptor effects on pulpal nociceptors. *J. Dent. Res.* 2008; 87: 948–52.
- Shimeno Y, Sugawara Y, Iikubo M, Shoji N, Sasano T. Sympathetic nerve fibers sprout into rat odontoblast layer but not into dentinal tubules in response to cavity preparation. *Neurosci. Lett.* 2008; 435: 73–7.
- Ahlberg KF. Dose dependent inhibition of sensory nerve activity in the feline dental pulp by antiinflammatory drugs. *Acta Physiol. Scand.* 1978; 102: 434–40.
- Goodis HE, Poon A, Hargreaves KM. Tissue pH and temperature regulate pulpal nociceptors. *J. Dent. Res.* 2006; 85: 1046–9.
- Modaresi J, Dianat O, Soluti A. Effect of pulpal inflammation on nerve impulse quality with or without anesthesia. *J. Endod.* 2008; 34: 438–41.
- Stein C. Peripheral mechanisms of opioid analgesia. *Anesth. Analg.* 1993; 76: 182–91.
- Sigurdsson A, Maixner W. Effects of experimental clinical noxious counterirritants on pain perception. *Pain* 1994; 57: 265–75.
- Byers MR, Taylor PE. Effect of sensory denervation on the response of rat molar pulp to exposure injury. *J. Dent. Res.* 1993; 72: 613–18.
- Sessle BJ. The neurobiology of facial and dental pain: present knowledge, future directions. *J. Dent. Res.* 1987; 66: 962–81.
- E. Villafuerte-Núñez, A.C. Téllez-Anguiano, O. Hernández-Díaz, R. Rodríguez-Vera, J. A. Gutiérrez-Gnecchi, J. L. Salazar-Martínez. Facial Edema Evaluation Using Digital Image Processing. Instituto Tecnológico de Morelia.
- Sudarshan, S Girish Rao, Karthik Venkataraghavan. Management of Postoperative Pain and Swelling following Mandibular third molar surgery with Newer Drugs – A Comparative Study. 2011 *Int. Journal of Contemporary Dentistry* 2(4).
- J. van der Westhuijzen, P. J. Becker, J. Morkel, J. A. Roelse. A randomized observer blind comparison of bilateral facial ice pack therapy with no ice therapy following third molar surgery. *Int. J. Oral Maxillofac. Surg.* 2005; 34: 281–286.
- M.D.S., F.D.S.R.C.S. C.S. Holland The development of a method of assessing swelling following third molar surgery *British Journal of Oral Surgery* Volume 17, Issue 2, 1979–1980, Pages 104–114.
- Messer EJ, Keller JJ. The use of intraoral dexamethasone after extraction of mandibular third molars. *Oral Surg Oral Med Oral Pathol.* 1975; 40: 594–8.

- Beirne OR, Hollander B. The effect of methylprednisolone on pain, trismus, and swelling after removal of third molars. *Oral Surg Oral Med Oral Pathol*. 1986;61:134–8.
- Berne RM, Levy MN, Koeppen BM, Stanton BA. *Physiology*. 5th Ed. New York: Elsevier inc; 2004.
- Hupp JR. Wound repair. In: Peterson LJ, Ellis E, Hupp JR, Tucker MR, editors. *Contemporary oral and maxillofacial Surgery*. 3rd ed. St Louis: Mosby; 1998. pp. 58–60.
- Alexander RE, Thronsdon RT. A review of perioperative corticosteroid use in dentoalveolar surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2000;90:406–15.
- Sortino F. and Cicciu' M. Strategies used to inhibit postoperative swelling following removal of impacted lower third molar. *Dent Res J (Isfahan)*. 2011 Oct-Dec; 8(4): 162–171.
- Thiago de Santana-Santos, Jadson-Alípio-Santana de Souza-Santos, Paulo-Ricardo-Saquete Martins-Filho, Luiz-Carlos-Ferreira da Silva, Emanuel-Dias de Oliveira e Silva, Ana-Claudia-Amorim Gomes. Prediction of postoperative facial swelling, pain and trismus following third molar surgery based on preoperative variables. *Med Oral Patol Oral Cir Bucal*. 2013 Jan 1;18 (1):e65-70. Journal section: Oral Surgery.
- Akadiri OA, Okoje VN, Arotiba JT. Identification of risk factors for short-term morbidity in third molar surgery. *Odontostomatol Trop*. 2008;31:5–10.
- Capuzzi P, Montebugnoli L, Vaccaro MA. Extraction of impacted third molars. A longitudinal prospective study on factors that affect postoperative recovery. *Oral Surg Oral Med Oral Pathol*. 1994;77:341-3.
- Slade GD, Foy SP, Shugars DA, Phillips C, White RP, Jr. The impact of third molar symptoms, pain, and swelling on oral health-related quality of life. *J Oral Maxillofac Surg*. 2004;62:1118-24.
- Grossi GB, Maiorana C, Garramone RA, Borgonovo A, Creminelli L, Santoro F. Assessing postoperative discomfort after third molar surgery: A prospective study. *J Oral Maxillofac Surg*. 2007;65:901–17.
- Curran JB, Kennett S, Young AR. An assessment of the use of prophylactic antibiotics in third molar surgery. *Int J Oral Surg*. 1974;3:1–6.
- Akadiri OA, Obiechina AE. Assessment of Difficulty in Third Molar Surgery—A Systematic Review. *J Oral Maxillofac Surg*. 2009;67:771–4.
- Yoshii T, Hamamoto Y, Muraoka S, Furudoi S, Komori T. Differences in postoperative morbidity rates, including infection and dry socket, and differences in the healing process after mandibular third molar surgery in patients receiving 1-day or 3-day prophylaxis with penicillin. *J Infect Chemother*. 2002;8:87–93.
- Tiwana PS, Foy SP, Shugars DA, Marciani RD, Conrad SM, Phillips C, et al. The impact of intravenous corticosteroids with third molar surgery in patients at high risk for delayed health-related quality of life and clinical recovery. *J Oral Maxillofac Surg*. 2005;63:55-62. 7.
- Shugars DA, Benson K, White RP, Jr., Simpson KN, Bader JD. Developing a measure of patient perceptions of short-term outcomes of third molar surgery. *J Oral Maxillofac Surg*. 1996;54:1402-8.
- Limeres J, Sanroman JF, Tomás I, Diz P. Patients' perception of recovery after third molar surgery following postoperative treatment with moxifloxacin versus amoxicillin and clavulanic acid: a randomized, double-blind, controlled study. *J Oral Maxillofac Surg*. 2009;67:286-91.
- Conrad SM, Blakey GH, Shugars DA, Marciani RD, Phillips C, White RP, Jr. Patients' perception of recovery after third molar surgery. *J Oral Maxillofac Surg*. 1999;57:1288-94. 10.
- de Santana Santos T, Calazans AC, Martins-Filho PR, Silva LC, de Oliveira ESED, Gomes AC. Evaluation of the muscle relaxant cyclobenzaprine after third-molar extraction. *J Am Dent Assoc*. 2011;142:1154-62.
- Mariano Sánchez-Siles, Luis Carlos Torres-Diez, Fabio Camacho-Alonso, Noemi Salazar-Sánchez, Jose Francisco Ballester Ferrandis. High Volume Local Anesthesia as a Postoperative Factor of Pain and Swelling in Dental Implants 2012 Wiley Periodicals, Inc. *Clinical Implant Dentistry and Related Research*, 16. (3), 2014.
- Thomas Urban, Ann Wenzel Discomfort experienced after immediate implant placement associated with three different regenerative techniques 2010 John Wiley & Sons A/S *Clin. Oral Impl. Res*. 21, 2010; 1271–1277.
- Kvist T, Reit C. Postoperative discomfort associated with surgical and nonsurgical endodontic retreatment. *Endod Dent Traumatol*. 2000;16:71-4.
- Chong BS, Pitt Ford TR. Postoperative pain after root-end resection and filling. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2005;100:762-6.

- Maria Peñarrocha-Diago, Laura Maestre-Ferrín, David Peñarrocha-Oltra, Cosme Gay-Escoda, Tomas von-Arx, Miguel Peñarrocha-Diago. Pain and swelling after periapical surgery related to the hemostatic agent used: Anesthetic solution with vasoconstrictor or aluminum chloride *Med Oral Patol Oral Cir Bucal*. 2012 Jul 1;17 (4):e594-600.
- Delilbasi C, Saracoglu U, Keskin A. Effects of 0.2% chlorhexidine gluconate and amoxicillin plus clavulanic acid on the prevention of alveolar osteitis following mandibular third molar extractions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2002;94:301–4.
- Kaczmarzyk T, Wichlinski J, Stypulkowska J, Zaleska M, Panas M, Woron J. Single-dose and multidose clindamycin therapy fails to demonstrate efficacy in preventing infectious and inflammatory complications in third molar surgery. *Int J Oral Maxillofac Surg*. 2007;36:417–22.
- Halpern LR, Dodson TB. Does prophylactic administration of systemic antibiotics prevent postoperative inflammatory complications after third molar surgery. *J Oral Maxillofac Surg*. 2007;65:177–85.
- Monaco G, Tavernese L, Agostini R, Marchetti C. Evaluation of Antibiotic Prophylaxis in Reducing Postoperative Infection After Mandibular Third Molar Extraction in Young Patients. *J Oral Maxillofac Surg*. 2009;67:1467–72.
- Martin MV, Kanatas AN, Hardy P. Antibiotic prophylaxis and third molar surgery. *Br Dent J*. 2005;198:26–30.
- Thomas DW, Hill CM. An audit of antibiotic prescribing in third molar surgery. *Br J Oral Maxillofac Surg*. 1997;35:126–8.
- Ataoglu H, Öz GY, Çandirli C, Kiziloğlu D. Routine antibiotic prophylaxis is not necessary during operations to remove third molars. *Br J Oral Maxillofac Surg*. 2008;46:133–5.
- Salmerón-Escobar JI, Del Amo-Fernández de Velasco A. Antibiotic prophylaxis in Oral and Maxillofacial Surgery. *Med Oral Patol Oral Cir Bucal*. 2006;11:E 292–6.
- Stuart E. Liebllich. Postoperative Prophylactic Antibiotic Treatment in Third Molar Surgery—A Necessity? *J Oral Maxillofac Surg*. 2004;62:9.
- Poeschl PW, Eckel D, Poeschl E. Postoperative Prophylactic Antibiotic Treatment in Third Molar Surgery—A Necessity? *J Oral Maxillofac Surg*. 2004;62:3–8.
- Stavropoulos MF, Shugars DA, Phillips C, Conrad SM, Fleuchaus PT, White RP., Jr Impact of topical minocycline with third molar surgery on clinical recovery and Health-Related Quality of Life Outcomes. *J Oral Maxillofac Surg*. 2006;64:1059–65.
- Sekhar CH, Narayanan V, Baig MF. Role of antimicrobials in third molar surgery: Prospective, double blind, randomized, placebo-controlled clinical study. *Br J Oral Maxillofac Surg*. 2001;39:134–7.
- Van Eeden SP, Bütow K. Post-operative sequelae of lower third molar removal: A literature review and pilot study on the effect of Covomycin D. *SADJ*. 2006;61:154–9.
- Pescatore C. A predictable gingival retraction system. *Compend Contin Educ Dent*. 2002;;23:7-12.
- Jensen SS, Yazdi PM, Hjørtting-Hansen E, Bosshardt DD, von Arx T. Haemostatic effect and tissue reactions of methods and agents used for haemorrhage control in apical surgery. *Int Endod J*. 2010;43:57-63.
- Beirne OR. Evaluation dexamethasone for reduction of postsurgical sequele of third molar removal. *J Oral Maxillofac Surg*. 1992;50:1182–3.
- Patten JR, Patten J, Hutchins MO. Adjunct use of dexamethasone in postoperative dental pain control. *Compendium*. 1992;13:580–584.
- Holte K, Kehlet H. Perioperative single-dose glucocorticoid administration: Pathophysiologic effects and clinical implications. *J Am Coll Surg*. 2002;195:694–711.
- Goodman LS, Gilman AG. The pharmacologic basis of therapeutics. 11th Ed. New York: McGraw-Hill; 2005.
- Koerner KR. Steroids in third molar surgery: A review. *Gen Dent*. 1987;35:459–63.
- Peterson LJ. Principles of oral and maxillofacial surgery. Vol. 1. Philadelphia: JB Lippincott; 1992. Principles of management of impacted teeth; p. 117.
- Milles M, Desjardins PJ. Reduction of postoperative facial swelling by low-dose methylprednisolone. *J Oral Maxillofac Surg*. 1993;51:987–91.
- Tiwana PS, Foy SP, Shugars DA, Marciani RD, Conrad SM, Phillips C, et al. The impact of intravenous corticosteroids with third molar surgery in patients at high risk for delayed health-related quality of life and clinical recovery. *J Oral Maxillofac Surg*. 2005;63:55–62.

- Esen E, Tasar F, Akhan O. Determination of the anti-inflammatory effects of methylprednisolone on the sequelae of third molar surgery. *J Oral Maxillofac Surg.* 1999;57:1201–6.
- Bystedt H, Nordenram A. Effect of methylprednisolone on complications after removal of impacted mandibular third molars. *Swed Dent J.* 1985;9:65–9.
- ElHag M, Coghlan K, Christmas P, Harvey W, Harris M. The anti-inflammatory effects of dexamethasone and therapeutic ultrasound in oral surgery. *Br J Oral Maxillofac Surg.* 1985;23:17–23.
- Schaberg SJ, Stuller CB, Edwards SM. Effect of methylprednisolone on swelling after orthognathic surgery. *J Oral Maxillofac Surg.* 1984;42:356–61.
- Ustün Y, Erdogan Ö, Esen E, Deniz E. Comparison of the effects of two doses of methylprednisolone on pain, swelling, and trismus after third molar surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2003;96:535–9.
- Schultze-Mosgau S, Schmelzeisen R, Frölich JC, Schmele H. Use of ibuprofen and methylprednisolone for the prevention of pain and swelling after removal of impacted third molars. *J Oral Maxillofac Surg.* 1995;53:2–7.
- Laureano Filho JR, Maurette PE, Allais M, Cotinho M, Fernandes C. Clinical comparative study of the effectiveness of two dosages of Dexamethasone to control postoperative swelling, trismus and pain after the surgical extraction of mandibular impacted third molars. *Med Oral Patol Oral Cir Bucal.* 2008;13:E129–32.
- Markiewicz MR, Brady MF, Ding EL, Dodson TB. Corticosteroids Reduce Postoperative Morbidity After Third Molar Surgery: A Systematic Review and Meta-Analysis. *J Oral Maxillofac Surg.* 2008;66:1881–94.
- Buyukkurt MC, Gungormus M, Kaya O. The effect a single dose prednisolone with and without diclofenac of pain, trismus, and swelling after removal of mandibular third molar. *J Oral Maxillofac Surg.* 2006;64:1761–6.
- Vegas-Bustamante E, Micó-Llorens J, Gargallo-Albiol J, Satorres-Nieto M, Berini-Aytés L, Gay-Escoda C. Efficacy of methylprednisolone injected into the masseter muscle following the surgical extraction of impacted lower third molars. *Int J Oral Maxillofac Surg.* 2008;37:260–3.
- Montgomery MT, Hoggs JP, Robers DL, Redding SW. The use of glucocorticosteroids to lessen the inflammatory sequelae following third molar surgery. *J Oral Maxillofac Surg.* 1990;48:179–87.
- Graziani F, D’Aiuto F, Arduino PG, Tonelli M, Gabriele M. Perioperative dexamethasone reduces post-surgical sequelae of wisdom tooth removal. A splitmouth randomized double-masked clinical trial. *Int J Oral Maxillofac Surg.* 2006;35:241–6.
- Suarez-Cunqueiro MM, Gutwald R, Reichman J, Otero-Cepeda XL, Schmelzeisen R. Marginal flap versus paramarginal flap in impacted third molar surgery: A prospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2003;95:403–8.
- Kirk DG, Liston PN, Tong DC, Love RM. Influence of two different flap designs on incidence of pain, swelling, trismus, and alveolar osteitis in the week following third molar surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2007;104:e1–6.
- Szmyd L. Impacted teeth. *Dent Clin North Am.* 1971;15:299–318.
- Monaco G, Daprile G, Tavernese L, Corinaldesi G, Marchetti C. Mandibular Third Molar Removal in Young Patients: An Evaluation of 2 Different Flap Designs. *J Oral Maxillofac Surg.* 2009;67:15–21.
- Pasqualini D, Cocero N, Castella A, Mela L, Bracco P. Primary and secondary closure of the surgical wound after removal of impacted mandibular third molars: a comparative study. *Int J Oral Maxillofac Surg.* 2005;34:52–7.
- Dubois DD, Pizer ME, Chinnis RJ. Comparison of primary and secondary closure techniques after removal of impacted mandibular 3rd molars. *J Oral Maxillofac Surg.* 1982;4:631–4.
- Holland CS, Hinole MO. The influence of closure or dressing of third molar sockets on post-operative swelling and pain. *Br J Oral Maxillofac Surg.* 1984;22:65–71.
- De Brabander EC, Cattaneo G. The effect of surgical drain together with a secondary closure technique on postoperative trismus, swelling and pain after mandibular 3rd molar surgery. *Int J Oral Maxillofac Surg.* 1988;17:119–21.
- Waite PD, Cherala S. Surgical outcomes for suture-less surgery in 366 impacted third molar patients. *J Oral Maxillofac Surg.* 2006;64:669–73.
- Cerqueira PR, Vasconcelos BC, Bessa-Nogueira RV. Comparative study of the effect of a tube drain in impacted lower third molar surgery. *J Oral Maxillofac Surg.* 2004;62:57–61.
- Chukwuneke FN, Oji C, Saheeb DB. A comparative study of the effect of using a rubber drain on postoperative discomfort following lower third molar surgery. *Int J Oral Maxillofac Surg.* 2008;37:341–4.
- Rakprasitkul S, Pairuchvej V. Mandibular third molar surgery with primary closure and tube drain. *Int J Oral Maxillofac Surg.* 1997;26:187–190.

- Ordulu M, Aktas I, Yalcin S, Azak AN, Evlioğlu G, Disçi R, et al. Comparative study of the effect of tube drainage versus methylprednisolone after third molar surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006;101:e96–100.
- Sortino F, Pedullà E, Masoli V. The Piezoelectric and Rotatory Osteotomy Technique in Impacted Third Molar Surgery: Comparison of Postoperative Recovery. *J Oral Maxillofac Surg.* 2008;66:2444–8.
- Shearer J, McManners J. Comparison between the use of an ultrasonic tip and a microhead handpiece in periradicular surgery: A prospective randomised trial. *Br J Oral Maxillofac Surg.* 2009;47:386–8.
- Robiony M, Polini F, Costa F, Sembronio S, Zerman N, Politi M. Endoscopically assisted intraoral vertical ramus osteotomy and piezoelectric surgery in mandibular prognathism. *Int J Oral Maxillofac Surg.* 2007;36:267–9.
- Price R, Lehmann JF, Boswell-Bessette S, Burleigh A, deLateur BJ. Influence of cryotherapy on spasticity at the human ankle. *Arch Phys Med Rehabil.* 1993;74:300–4.
- Curl WW, Smith BP, Marr A, Rosencrance E, Holden M, Smith TL. The effect of contusion and cryotherapy on skeletal muscle microcirculation. *J Sports Med Phys Fitness.* 1997;37:279–86.
- Thermann H, Krettek C, Hufner T, Schratt HE, Albrecht K, Tscherne H. Management of calcaneal fractures in adults: conservative versus operative treatment. *Clin Orthop Relat Res.* 1998;353:107–24.
- Van der Westhuijzen AJ, Becker PJ, Morkel J, Roelse JA. A randomized observer blind comparison of bilateral facial ice pack therapy with no ice therapy following third molar surgery. *Int J Oral Maxillofac Surg.* 2005;34:281–6.
- Lehmann JF. *Therapeutic Heat and Cold.* Baltimore: Williams and Wilkins; 1990. pp. 590–632.
- Sortino F, Messina G, Pulvirenti G. Evaluation of postoperative mucosa and skin temperature after surgery for impacted third molar. *Minerva Stomatol.* 2003;52:393–9.
- Oosterveld FG, Rasker JJ, Jacobs JW, Overmars HJ. The effect of local heat and cold therapy on the intraarticular and skin surface temperature of the knee. *Arthritis Rheum.* 1992;35:146–51.
- Weston M, Taber C, Casagrande L, Cornwall M. Changes in local blood volume during cold gel application to traumatized ankles. *J Orthop Sports Phys Ther.* 1994;19:197–9.
- Laureano Filho JR, de Oliveira e Silva ED, Batista CL, Gouveia FM. The influence of cryotherapy on reduction of swelling, pain and trismus after third-molar extraction. *J Am Dent Assoc.* 2005;136:774–8.
- Greenstein G. Therapeutic efficacy of cold therapy after intraoral surgical procedures: A literature review. *J Periodontol.* 2007;78:790–800.
- Moore RJ, Watts JJ, Hood JA, Burrit DJ. Intraoral temperature variation over 24 hours. *Eur J Orthod.* 1999;21:249–61.
- Nusair YM. Local application of ice bags did not affect postoperative facial swelling after oral surgery in rabbits. *Br J Maxillofac Surg.* 2007;45:48–50.
- Markovic A, Todorovic Lj. Effectiveness of dexamethasone and low-power laser in minimizing oedema after third molar surgery: A clinical trial. *Int J Oral Maxillofac Surg.* 2007;36:226–9.
- Bahn SL. Glucocorticosteroids in dentistry. *J Am Dent Assoc.* 1982;105:476–81.
- Esen E, Tasar F, Akhan O. Determination of the anti-inflammatory effects of methylprednisolone on the sequelae of third molar surgery. *J Oral Maxillofac Surg.* 1999;57:1201–6.
- Barron RP, Benoliel R, Zeltser R, Eliav E, Nahlieli O, Gracely RH. Effect of dexamethasone and dipyrone on lingual and inferior alveolar nerve hypersensitivity following third molar extractions: Preliminary report. *J Orofac Pain.* 2004;18:62–8.
- Spierings EL, Dhadwal S. Orofacial pain after invasive dental procedures: neuropathic pain in perspective. *Neurologist.* 2015 Jan;19(2):56–60. doi: 10.1097/NRL.0b013e3182811968.
- Benoliel R, Eliav E. Neuropathic orofacial pain. *Oral Maxillofac Surg Clin North Am.* 2008 May;20(2):237–54.
- Benoliel R, Sharav Y. Compendium of Continuing Education in Dentistry (Jamesburg, N.J. : 1995) [1998, 19(11):1099–102, 1104, passim; quiz 1116] Department of Oral Diagnosis, Oral Medicine, and Oral Radiology, Hebrew University, Hadassah School of Dental Medicine, Jerusalem, Israel.
- Okeson JP (editor). *Orofacial pain: guidelines for assessment, diagnosis and management.* Chicago, Quintessence; 1996.
- De Leeuw R. *Orofacial pain: guidelines for assessment, diagnoses and management.* Hanover Park (IL): Quintessence; 2008.
- Lewis MA, Sankar V, De Laat A, Benoliel R. Management of neuropathic orofacial pain. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2007;103(Suppl):S32.e1–24.

- Campbell RL, Parks KW, Dodds RN. Chronic facial pain associated with endodontic therapy. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1990;69:287-90.
- Rasmussen PV, Sindrup SH, Jensen TS, Bach FW. Symptoms and signs in patients with suspected neuropathic pain. *Pain* 2004;110:461-9.
- Lamas Pelayo J, Peñarrocha Diago M, Martí Bowen E, Peñar-rocha Diago M. Intraoperative complications during oral implantology. *Med Oral Patol Oral Cir Bucal* 2008;13:E239-43.
- Drangsholt M, Truelove EL, Yamuguchi G. The case of a 52-year-old woman with chronic tooth pain unresolved by multiple traditional dental procedures: an evidence-based review of the diagnosis of trigeminal neuropathic pain. *J Evid Based Dent Pract* 2005;5:1-10.
- Kalladka M, Proter N, Benoliel R, Czerninski R, Eliav E. Mental nerve neuropathy: patient characteristics and neurosensory changes. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;106: 364-70.
- Vickers ER, Cousins MJ. Neuropathic orofacial pain. Part 1—prevalence and pathophysiology. *Aust Endod J* 2000;26:19-26.
- Melis M, Lobo SL, Ceneviz C, Zawawi K, Al-Badawi E, Maloney G, Mehta N. Atypical odontalgia: a review of the literature. *Headache* 2003;43:1060-74.
- Lynch ME, Elgeneidy AK. The role of sympathetic activity in neuropathic orofacial pain. Department of Psychiatry, Dalhousie University, Queen Elizabeth II Health Sciences Center, Halifax, Nova Scotia, Canada. *Journal of Orofacial Pain* [1996, 10(4):297-305].
- Michael A.O. Lewis, Vidya Sankar, Antoon De Laat, Rafael Benoliel. Management of neuropathic orofacial pain *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* Volume 103, Supplement, March 2007, Pages S32.e1–S32.e24. Fourth World Workshop on Oral Medicine.
- Melzack R. The McGill Pain Questionnaire: major properties and scoring methods. *Pain*. 1975 Sep;1(3):277-99.
- Boychuk DG, Goddard G, Mauro G, Orellana MF. The effectiveness of cannabinoids in the management of chronic nonmalignant neuropathic pain: a systematic review. *J Oral Facial Pain Headache*. 2015 Winter;29(1):7-14.
- Gregg JM. Neuropathic complications of mandibular implant surgery: review and case presentations *Ann R Australas Coll Dent Surg*. 2000 Oct;15:176-80.
- Okeson JP, Falace DA. Nonodontogenic toothache. *Dent Clin North Am* 1997;41:367-387.
- Padilla M, Clark GT, Merrill RL. Topical medications for oro- facial neuropathic pain: a review. *J Am Dent Assoc* 2000;131: 184-95.
- Heir G, Karolchek S, Kalladka M, Vishwanath A, Gomes J, Khatri R, et al. Use of topical medication in orofacial neuropathic pain: a retrospective study. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;105:466-9.
- Marbach JJ, Raphael KG. Phantom tooth pain: a new look at an old dilemma. *Pain Med* 2000;1:68-77.
- Forsell H, Jääskeläinen S, List T, Svensson P, Baad-Hansen L. An update on pathophysiological mechanisms related to idiopathic oro-facial pain conditions with implications for management. *J Oral Rehabil*. 2014 Dec 8.
- Rory Nolan Maher Kemmoona Ioannis Polyzois Noel Claffey. The influence of prophylactic antibiotic administration on post-operative morbidity in dental implant surgery. A prospective double blind randomized controlled clinical trial. *Clin. Oral Impl. Res.* 25, 2014, 252–259.
- Wah Ching Tan, Marianne Ong, Jie Han, Nikos Mattheos, Bjarni E. Pjetursson, Alex Yi-Min Tsai, Ignacio Sanz, May C.M. Wong, Niklaus P. Lang on Behalf of the ITI Antibiotic Study Group. Effect of systemic antibiotics on clinical and patient-reported outcomes of implant therapy – a multicenter randomized controlled clinical trial. *Clin. Oral Impl. Res.* 25, 2014, 185–193.
- Sudhakar V, Vinodhini TS, Mohan AM, Srinivasan B, Rajkumar BK. The efficacy of different pre- and post-operative analgesics in the management of pain after orthodontic separator placement: A randomized clinical trial. *J Pharm Bioallied Sci.* 2014 Jul;6(Suppl 1):S80-4.
- Alberto Mazzocchi, and Fabio Montanaro. Observational study of the use of Symphytum 5CH in the management of pain and swelling after dental implant surgery. *Homeopathy* (2012) 101, 211e 216.
- Thornhill MH, Dayer MJ, Forde JM, et al. Impact of the NICE guideline recommending cessation of antibiotic prophylaxis for prevention of infective endocarditis: before and after study. *BMJ* 2011; 3: 342.
- Laskin DM, Dent CD, Morris HF, Ochi S, Olson JW. The influence of preoperative antibiotics on success of endosseous implants at 36 months. *Ann Periodontol* 2000; 5: 166e174.
- Andrade RJ, Lucena MI, Fernandez MC, et al. Drug-induced liver injury: an analysis of 461 incidences submitted to the Spanish registry over a 10-year period. *Gastroenterology* 2005; 129: 512 e 521.
- Kaczmarzyk T. Abuse of antibiotic prophylaxis in third molar surgeries. *J Oral Maxillofac Surg* 2009; 67: 2551e2552.

Kreissl ME, Gerds T, Muche R, Heydecke G, Strub JR. Technical complications of implant-supported fixed partial dentures in partially edentulous cases after an average observation period of 5 years. *Clin Oral Implants Res* 2007; 18: 720e726.

Alsaadi G, Quirynen M, Komarek A, van Steenberghe D. Impact of local and systemic factors on the incidence of late oral implant loss. *Clin Oral Implants Res* 2008; 19: 670e676.

Siddiqi A, Payne AG, De Silva RK, Duncan WJ. Titanium allergy: could it affect dental implant integration? *Clin Oral Implants Res* 2011; 22: 673e680.

Mohabbat O, Younos MS, Merzad AA, Srivastava RN, Sediq GG, Aram GN. An outbreak of hepatic veno-occlusive disease in north-western Afghanistan. *Lancet* 1976; 2: 269e271.

Ridker PM, Ohkuma S, McDermott WV, Trey C, Huxtable RJ. Hepatic veno-occlusive disease associated with the consumption of pyrrolizidine-containing dietary supplements. *Gastroenterology* 1985; 88: 1050e1054.

Al-Ouf K, Salti L. Postinsertion pain in region of mandibular dental implants: a case report. *Implant Dent* 2011; 20: 27e31. 27 Vermeulen F. *Prisma, the arcane of Materia Medica illuminated*. Haarlem: Hemryss Pub, 2002.

Bach N, Thung SN, Schaffner F. Comfrey herb tea-induced hepatic veno-occlusive disease. *Am J Med* 1989; 87: 97e99.

Rode D. Comfrey toxicity revisited. *Trends Pharmacol Sci* 2002; 23: 497e499.

Kucera M, Barna M, Horacek O, Kovarik J, Kucera A. Efficacy and safety of topically applied Symphytum herb extract cream in the treatment of ankle distortion: results of a randomized controlled clinical double blind study. *Wien Med Wochenschr* 2004; 154: 498e507.

Sakakura CE, Neto RS, Bellucci M, Wenzel A, Scaf G, Marcantonio E Jr. Influence of homeopathic treatment with Comfrey on bone density around titanium implants. A digital subtraction radiography study in rats. *Clin Oral Implants Res* 2008; 19: 624e628.

H. O. Kazancioglu, E. Kurklu, S. Ezirganli: Effects of ozone therapy on pain, swelling, and trismus following third molar surgery. *Int. J. Oral Maxillofac. Surg.* 2014; 43: 644–648. # 2013 International Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Hunter KM. A clinical evaluation of benzy-damine hydrochloride. *Aust Dent J* 1978; 23: 164–6.

McKenna DF, Borzabadi-Farahani A, Lynch E. The effect of subgingival ozone and/or hydrogen peroxide on the development of peri-implant mucositis: a double-blind randomized controlled trial. *Int J Oral Maxillofac Implants.* 2013 Nov-Dec; 28(6): 1483-9.

Agrillo A, Petrucci MT, Tedaldi M, Mustazza MC, Marino SM, Gallucci C et al. New therapeutic protocol in the treatment of avascular necrosis of the jaws. *J Craniofac Surg* 2006; 17: 1080-1083.

Lynch E. Comment on "The application of ozone in dentistry: A systematic review of the literature". *J Dent.* 2009 May; 37(5): 406-10; author reply 411-2. doi: 10.1016/j.jdent.2008.11.002. Epub 2009 Mar 19.

Hammad HM, Hammad MM, Abdelhadi IN, Khalifeh MS. Effects of topically applied agents on intra-oral wound healing in a rat model: a clinical and histomorphometric study. *Int J Dent Hyg* 2011; 9: 9–16.

Chen WY, Abatangelo G. Functions of hyaluronan in wound repair. *Wound Repair Regen* 1999; 7: 79–89.

Moseley R, Waddington RJ, Embery G. Hyaluronan and its potential role in periodontal healing. *Dent Update* 2002; 29: 144–8.

Gontiya G, Galgali SR. Effect of hyaluronan on periodontitis: a clinical and histological study. *J Indian Soc Periodontol* 2012; 16: 184–92.

Laurent TC, Fraser JR. Hyaluronan. *FASEB J* 1992; 6: 2397–404.

Polat HB, Ozdemir H, Ay S. Effect of different mouth rinses on third molar surgery-related oral malodor. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008; 105: e1–8.

Epstein JB, Silverman Jr S, Paggiarino DA, Crockett S, Schubert MM, Senzer NN, et al. Benzydamine HCl for prophylaxis of radiation-induced oral mucositis: results from a multicenter, randomized, double-blind, placebo-controlled clinical trial. *Cancer* 2001; 92: 875–85.

Whiteside MW. A controlled study of benzydamine oral rinse ("Diffiam") in general practice. *Curr Med Res Opin* 1982; 8: 188–90.

Devanand Gupta¹, Deepak Ranjan Dalai², Swapnadeep³, Parul Mehta⁴, Niranjana Prasad Indra B⁵, Saurabh Rastogi⁶, Ankita Jain², Mudita Chaturvedi⁷, Saumya Sharma⁸, Sanjeev Singh⁹, Shruti Gill¹⁰, Nisha Singh¹¹, Rajendra Kumar Gupta¹²

Acupuncture (針灸 Zhēn Jiǔ) – An Emerging Adjunct in Routine Oral Care. *Journal of Traditional and Complementary Medicine* Vol. 4, No. 4, pp. 218-223.

Ulett GA, Han S, Han JS. Electroacupuncture: Mechanisms and clinical application. *Biol Psychiatry* 1998;44:129-38.

Richardson PH, Vincent CA. Acupuncture for the treatment of pain: A review of evaluative research. *Pain* 1986;24:15-40.

Newmeyer JA, Johnson G, Klot S. Acupuncture as a detoxification modality. *J Psychoactive Drugs* 1984;16:241-61.

Lundeberg T. Peripheral effects of sensory nerve stimulation (acupuncture) in inflammation and ischemia. *Scand J Rehabil Med Suppl* 1993;29:61-86.

Rosted P. The use of acupuncture in dentistry: A review of the scientific validity of published papers. *Oral Dis* 1998;4:100-4.

Ernst E, Pittler M H. The effectiveness of acupuncture in treating acute dental pain: A systematic review. *Br Dent J* 1998;184:443-7.

Bowsher D. Physiology and pathophysiology of Pain. *Acupunct Med* 1990;7:17-20.

Macdonald A. Acupuncture analgesia and Therapy – Part 2. *Acupunct Med* 1990;8:44-9.

Chng HS, Pitt Ford TR, McDonald F. Effects of Prilocaine local anaesthetic solutions on pulpal blood flow in maxillary canines. *Endod Dent Traumatol* 1996;12:89-95.

Rubik B. Can Western science provide a foundation for acupuncture? *Altern Ther Health Med* 1995;1:41-7.

Rosted P, Bundgaard M. Can Acupuncture reduce the induction time of a local anaesthetic? A pilot study. *Acupunct Med* 2003;21:92-9.

Kho H, Robertson EN. The mechanisms of acupuncture analgesia: Review and update. *Am J Acupunct* 1997;25:261-81.

Lao L, Berman S, Hamilton GR, Langenberg P, Berman B. Evaluation of acupuncture for pain control after oral surgery. *Arch Otolaryngol Head Neck Surg* 1999;125:567-72.

Lao L, Bergman S, Lamgenberg P, Wong RH, Berman B. Efficacy of Chinese acupuncture on Ostoperative oral surgery pain. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 1995;79:423-8.

Cho SH, Whang WW. Acupuncture for temporomandibular disorders: A systematic review. *J Orofac Pain* 2010 Spring; 24:152-62.

Raustia AM, Pohjola RT, Virtanen KK. Acupuncture compared with stomatognathic Treatment for TMJ dysfunction. Part II: Components of the Dysfunction index. *J Prosthet Dent* 1986;55:372-6.

Lu L. Clinical observation on 20 cases of Trigeminal Neuralgia treated by Acupuncture. *Bengbu Med* 1995;12:21.

Xie JM, Lu YX. Crossing three-needling plus point injection for treating 35 cases of Trigeminal Neuralgia. *Clin J Acupunct* 2005;21:37-8.

Li Y, Liang FR, Yu SG, Li CD, Hu LX, Zhou D, et al. Efficacy of acupuncture and moxibustion in treating Bell's palsy: A multicenter randomized controlled trial in China. *Chin Med J* 2004 (Engl) 2004;117:1502-6.

Karst M, Winterhalter M, Munte S, Francki B, Hondronikos A, Eckardt A, et al. Auricular acupuncture for dental anxiety: A randomised controlled trial. *Anesth Analg* 2007;104:295-300.

Rosted P, Bundgaard M, Fiske J, Pedersen AM. The use of acupuncture in controlling the gag reflex in patients Requiring an upper alginate impression: An audit. *Br Dent J* 2006;201:721-5.

Somri M, Vaida SJ, Sabo E, Yassain G, Gankin I, Gaitini LA. Acupuncture versus odansetron In the preventing of postoperative vomiting. A study of children undergoing dental surgery. *Anaesthesia* 2001;56:927-32.

Allen PF. Assessment of oral health related quality of life. *Health Qual Life Outcomes*. 2003;1:40.

EuroQOL group. EuroQOL group: a new facility for the measurement of health-related quality of life. *Health Policy*. 1990;16: 199-208.

Brazier J, Roberts J, Deverill M. The estimation of a preference- based measure of health from the SF-36. *J Health Econ*. 2002; 21(2):271-92.

Torrance GW, Feeny D. Utilities and quality-adjusted life years. *Int J Tech Assess Health Care*. 1989;5:559-75.

- Drummond MF. Methods for the economic evaluation of health care programmes. 2nd ed. Oxford: Oxford Univ Press; 1997.
- Yamamoto Y. Preference based measure, preference-based-QOL measurement. Development Japanese version of SF-6D (in Japanese). HOPE International Newsletter No. 22. HOPE International Development Agency, Vancouver; 2009.
- Torrance GW. A utility maximization model for evaluation of health care programs. *Health Serv Res.* 1972;7:118–33.
- Neumann PJ. Growth and quality of the cost-utility literature, 1976–2001. *Value Health.* 2005;8:3–9.
- Patrick DL. Measuring preferences for health states worse than death. *Med Decis Mak.* 1994;14:9–18.
- Brauer CA. Trends in the measurement of health utilities in published cost-utility analyses. *Value Health.* 2006;9:213–8.
- Uemura T, Moriguchi N, Han N, Feeny D, Shimada N, Kondo T, et al. Japanese health utilities index Mark 3 (HUI3) properties in a community sample. *Qual Life Res.* 2000;9:1068.
- Brazier J. A comparison of the EQ-5D and SF-6D across seven patient groups. *Health Econ.* 2004;13:873–84.
- Luo N. A comparison of the EuroQol-5D and the Health Utilities Index mark 3 in patients with rheumatic disease. *J Rheumatol.* 2003;30:2268–74.
- Goldberg DP, Blackwell B. Psychiatric illness in general practice. A detailed study using a new method of case identification. *Br Med J.* 1970;1:439–43.
- Rana M, Gellrich NC, Ghassemi A, Gerressen M, Riediger D, Modabber A: Three-dimensional evaluation of postoperative swelling after third molar surgery using two different cooling therapy methods: a randomized observer-blind prospective study. *J Oral Maxillofac Surg* 2011, 69:2092–2098.
- Gruber M, Häusler G: Simple, robust and accurate phase-measuring triangulation. *Optik* 1992, 89:118–122.
- Laboureux X, Häusler G: Localization and registration of three-dimensional objects in space – where are the limits? *Appl Optics* 2001, 40:5206–5216.
- Hartmann J, Meyer-Marcotty P, Benz M, Häusler G, Stellzig-Eisenhauer A: Reliability of a method for computing facial symmetry plane and degree of asymmetry based on 3D-data. *J Orofac Orthop* 2007, 68:477–490.
- Besl PJ, McKay N: A method for registration of 3-D shapes. *IEEE PAMI* 1992, 14:239–256.
- Zhang Z: Proc BMVC. On local matching of free-form curves; 1992:347–356.
- B. Abbas and A. H. Lichtman, Basic Immunology. Functions and Disorders of the Immune System, 3rd edition, 2009.
- Goldsby Richard, Immunology, Editorial Mc Graw Hill, 5th edition, 2004.
- M. A. Amin and D. M. Laskin, “Prophylactic use of indo- methacin for prevention of postsurgical complications after removal of impacted third molars,” *Oral Surgery Oral Medicine and Oral Pathology*, vol. 55, no. 5, pp. 448–451, 1983.
- M. Averbuch and M. Katzper, “Baseline pain and response to analgesic medications in the postsurgery dental pain model,” *Journal of Clinical Pharmacology*, vol. 40, no. 2, pp. 133–137, 2000.
- D. R. Mehlisch, “The efficacy of combination analgesic therapy in relieving dental pain,” *Journal of the American Dental Association*, vol. 133, no. 7, pp. 861–871, 2002.
- M. Corral and F. H. Flores, “Prevalencia de inclusión dental y patología asociada en pacientes de la Clínica de la Facultad de Odontología Mexicali de la UABC,” *Revista Odontológica Mexicana*, vol. 9, no. 2, pp. 84–91, 2005.
- K. Petersen, “Anti inflammatory and analgetic effects of indomethacin following removal of impacted mandibular third molars,” *International Journal of Oral Surgery*, vol. 4, no. 6, pp. 267–276, 1975.
- A.V.vanGool, J.J.TenBosch, and G.Boering, “A photographic method of assessing swelling following third molar removal,” *International Journal of Oral Surgery*, vol. 4, no. 3, pp. 121–129, 1975.
- Sacha Lardenoye, Ed Theunissen, Berry Cleffken, Peter RG Brink, Rob A de Bie, and Martijn Poeze. The effect of taping versus semi-rigid bracing on patient outcome and satisfaction in ankle sprains: a prospective, randomized controlled trial Lardenoye et al. *BMC Musculoskeletal Disorders* 2012, 13:81.
- Chen-Yu Huang, Tsung-Hsun Hsieh, Szu-Ching Lu and Fong-Chin Su. Effect of the Kinesio tape to muscle activity and vertical jump performance in healthy inactive people.
- Huang et al. *BioMedical Engineering OnLine* 2011, 10:70
- Marcin Krajczyk, Katarzyna Bogacz, Jacek Luniewski, and Jan Szczepielniak. The Influence of Kinesio Taping on the Effects of Physiotherapy in Patients after Laparoscopic Cholecystectomy. *The Scientific World Journal*. Volume 2012, Article ID 948282, 5 pages.
- Hacer Hicran fi, Selvin, Sinem Suner, Hayati, Hasan. Does Kinesio taping in addition to exercise therapy improve the outcomes

in subacromial impingement syndrome? A randomized, double-blind, controlled clinical trial. *Acta Orthop Traumatol Turc* 2013;47(2):104-110.

Hannah L. Stedje, Ryan M. Kroskie, Carrie L. Docherty. Kinesio Taping and the Circulation and Endurance Ratio of the Gastrocnemius Muscle *Journal of Athletic Training* 2012;47(6):635–642.

A. Karlon, S. Barsela, A systematic review of the effectiveness of Kinesio Taping® - Fact or fashion? *EUR J PHYS REHABIL MED* 2013;49.

Kase K. Illustrated Kinesio-Taping. KEN'IKAI Information, Al-buquerque, Canada; 1997.

Kase K, Wallis J, Kase T. Clinical therapeutic applications of the Kinesio taping methods. Kinesio Taping Association, Tokyo; 2003.

Kase K, Hashimoto T, Okane T. Kinesio taping perfect manual. Kinesio Taping Association, Tokyo; 1998.

Osterhues DJ. The use of kinesio taping in the management of traumatic patella dislocation. A case study. *Physiother Theory Pract* 2004;20:267-70.

Walsh SF. Treatment of a brachial plexus injury using kinesio-tape and exercise. *Physiother Theory Pract* 2010; 26:490-6.

Hwang-Bo g, Lee JH. Effects of kinesio taping in a physical therapist with acute low back pain due to patient handling: A case report. *International J Occup Med Environ Health* 2011; 24:320-3.

Asukawa A, Patel P, Sisung C. Pilot study: investigating the 22. Effects of Kinesio taping in an acute pediatric rehabilitation setting. *Am J Occup Ther* 2006;60:104-10.

Kalichman L, Vered E, Volchek L. Relieving symptoms of meralgia paresthetica using Kinesio taping: a pilot study. *Arch Phys Med Rehabil* 2010;91:1137-9.

Halseth T, McChesney JW, DeBeliso M, Vaughn R, Lien J. The effects of kinesio taping on proprioception at the ankle. *J Sports Sci Med Journal* 2004;3:1-7.

Chang HY, Chou KY, Lin JJ, Lin CF, Wang CH. Immediate effect of forearm Kinesio taping on maximal grip strength and force sense in healthy collegiate athletes. *Phys Ther Sport* 2010;11:122-7.

Cerrahlarda Ameliyat Sonrası Gelişen Kas İskelet Sistemi Ağrıları Üzerinde Kinesio Bantlama Tekniğinin Fonksiyonel Performansa Etkisi. The Effect of Kinesiotape Application on Functional Performance in surgeons Who have Musculoskeletal Pain after Performing surgery. *Turkish Neurosurgery* 2012, Vol: 22, No: 1, 83-89.

Kenzo Kase, D.C., and Tatsuyuki Hashimoto, Ph.D. Changes in the Volume of the Peripheral Blood Flow by using Kinesio Taping® 1997-98.

Kayoko Maruko, Director of Potential Development Support Center, Hokkaido Japan Kinesio Taping® with Aqua-Therapy for Pediatric Disability involving Neurological Impairment. 15th Annual Kinesio Taping International Symposium Review. (pp. 70-73) Tokyo, Japan: Kinesio Taping Association.

Nosaka, K. (1999). The Effect of Kinesio Taping® on Muscular Micro-Damage Following Eccentric Exercises. 15th Annual Kinesio Taping International Symposium Review. (pp. 70-73) Tokyo, Japan: Kinesio Taping Association.

Murray, H. (2000). Kinesio Taping®, Muscle Strength and ROM after ACL Repair. *Journal of Orthopedic and Sports Physical Therapy*, 30, 1.

Tsai H, Hung H, Yang J, Huang C, Tsao J. Could kinesio tape replace the bandage in decongestive lymphatic therapy for breast-cancer-related lymphedema? A pilot study. *Support Care Cancer* 2009;17:1353-60.

Bialoszewski D, Wozniak W, Zarek S. Clinical efficacy of kinesiology taping in reducing edema of the lower limbs in patients treated with the ilizarov method – preliminary report. *Ortopedia Traumatologia Rehabilitacja* 2009;11:46-54.

Briem K, Eythörsdóttir H, Magnúsdóttir Rg, Pálmarsson R, Rúnarsdóttir T, Sveinsson T. Effects of kinesio tape compared with nonelastic sports tape and the untaped ankle during a sudden inversion perturbation in male athletes. *J Orthop Sports Phys Ther* 2011;41:328-35.

Slupik A, Dwornik M, Bialoszewski D, Zych E. Effect of Kinesio taping on bioelectrical activity of vastus medialis muscle: pre-liminary report. *Ortop Traumatol Rehabil* 2007;9:644-51.

Huang CY, Hsie TH, Lu SC, Su FC. Effect of the kinesio tape to muscle activity and vertical jump performance in healthy inactive people. *Biomed Eng Online* 2011;10:70.

Yoshida A, Kahanov L. the effect of kinesio taping on lower trunk range of movements. *Res Sports Med* 2007;15:103-12.

- Sherrington C, Herbert RD, Maher CG, Moseley AM. PEDro: a database of randomised trials and systematic reviews in physiotherapy. *Manual Therapy* 2000;5:223-6.
- Thelen MD, Duabier JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: A randomized, double-blinded, clinical trial. *J Orthop Sports Phys Ther* 2008;38:389-95.
- Hsu Y, Chen W, Lin H, Wang W, Shih Y. The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome. *J Electromyogr Kinesiol* 2009;19:1092-9.
- Kaya E, Zinnuroglu M, Tugcu I. Kinesio taping compared to physical therapy modalities for the treatment of shoulder impingement syndrome. *Clin Rheumatol* 2011;30:201-7.
- Aytar A, Ozunlu N, Surenkok O, Baltaci G, Oztup P, Karatas M. Initial effects of kinesio taping in patients with patellofemoral pain syndrome: A randomized, double-blind study. *Isokinet Exerc Sci* 2011;19:135-42.
- Akbas E, Atay AO, Yuskel I. The effects of additional kinesio taping over exercise in the treatment of patellofemoral pain syndrome. *Acta Orthop Traumatol Turc* 2011;45:335-41.
- Paoloni M, Bernetti A, Fratocchi G, Mangone M, Parrinello L, Del Pilar Cooper M et al. Kinesio taping applied to lumbar muscles influences in chronic low back pain patients. *Eur J Phys Rehabil Med* 2011;47:237-44.
- Tsai CT, Chang WD, Lee JP. Effects of short-term treatment with kinesiotaping for plantar fasciitis. *J Musculoskelet Pain* 2010;18:71-80.
- Gonzales-Iglesias J, Fernandez-De-Las-Penas C, Cleland J, Huijbregts P, Gutierrez-Vega MDR. Short-Term effects of cervical kinesio taping on pain and cervical range of motion with acute whiplash injury: A randomized clinical trial. *J Orthop Sports Phys Ther* 2009;39:515-21.
- Firth BL, Dingley P, Davies ER, Lewis JS, Alexander CM. The effect of kinesiotape on function, pain and motoneural excitability in healthy people and people with achilles tendinopathy. *Clin J Sport Med* 2010;20:416-21.
- Karadag-Sayagi E, Cubukcu-Aydoseli K, Kablan N, Ofluoglu D. The role of Kinesiotaping combined with botulinum toxin to reduce spasticity after stroke. *Top Stroke Rehabil* 2010;17:318.
- Yasukawa A, Patel P, Sisung C. Pilot study: investigating the effects of Kinesio taping in an acute pediatric rehabilitation setting. *Am J Occup Ther* 2006;60:104-10.
- Kalichman L, Vered E, Volchek L. Relieving symptoms of meralgia paresthetica using Kinesio taping: a pilot study. *Arch Phys Med Rehabil* 2010;91:1137-9.
- Tsai H, Hung H, Yang J, Huang C, Tsao J. Could kinesio tape replace the bandage in decongestive lymphatic therapy for breast-cancer-related lymphedema? A pilot study. *Support Care Cancer* 2009;17:1353-60.
- Bialoszewski D, Wozniak W, Zarek S. Clinical efficacy of kinesiology taping in reducing edema of the lower limbs in patients treated with the ilizarov method – preliminary report. *Ortopedia Traumatologia Rehabilitacja* 2009;11:46-54.
- Fu TC, Wong AMK, Pei YC, Wu KP, Chou SH, Lin YC. Effects of kinesio taping on muscle strength in athletes-A pilot study. *J Sci Med Sport* 2008;11:198-201.
- Ali Modabber, Madiha Rana, Alireza Ghassemi, Marcus Gerressen, Nils Claudius Gellrich, Frank Hölzle and Majeed Rana. Three-dimensional evaluation of postoperative swelling in treatment of zygomatic bone fractures using two different cooling therapy methods: a randomized, observer-blind, prospective study. *Trialsjournal Trials* 2013, 14:238.
- Oliver Ristow & Bettina Hohlweg-Majert & Stephen R. Stürzenbaum & Victoria Kehl & Steffen Koerdt & Lilian Hahnefeld & Christoph Pautke. Therapeutic elastic tape reduces morbidity after wisdom teeth removal—a clinical trial *Clin Oral Invest* (2014) 18:1205–1212.
- Oliver Ristow, Christoph Pautke, Victoria Kehl, Steffen Koerdt, Katharina Schwärzler, Lilian Hahnefeld, Bettina Hohlweg-Majert. Influence of kinesiology tape on postoperative swelling, pain and trismus after zygomatico-orbital fractures *Journal of Cranio-Maxillo-Facial Surgery* 42 (2014) 469-476.
- Gillian A., Hawker, Samra M, Tetyana Kedzerska, and melissa French. Measures of Adult Pain Arthritis Care & Research Vol. 63, No. S11, November 2011, pp S240–S252.
- Oliver Ristow, MD, Bettina Hohlweg-Majert, Victoria Kehl, Steffen Koerdt, Lilian Hahnefeld, and Christoph Pautke. Does Elastic Therapeutic Tape Reduce Postoperative Swelling, Pain, and Trismus After Open Reduction and Internal Fixation of Mandibular Fractures? *J Oral Maxillofac Surg* 71:1387-1396, 2013.
- Niklaus Egloff, Rafael JA, Cámara, Roland von Känel, Nicole Klingler, Elizabeth Marti and Marie-Louise Gander Ferrari. Pain drawings in somatoform-functional pain Egloff et al. *BMC Musculoskeletal Disorders* 2012, 13:257.
- Bo C Bertilson, Eva Brosjö, Hans Billing, Lars-Erik Strender. Assessment of nerve involvement in the lumbar spine: agreement between magnetic resonance imaging, physical examination and pain drawing findings Bertilson et al. *BMC Musculoskeletal*

Disorders 2010, 11:202.

Osunde OD, Adebola RA, Omeje UK: Management of inflammatory complications in third molar surgery: A review of the literature. *Afr Health Sci* 11:530, 2011.

Kondoh T, Hamada Y, Kamei K, et al: Comparative study of intra-articular irrigation and corticosteroid injection versus closed reduction with intermaxillary fixation for the management of mandibular condyle fractures. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 98:651, 2004.

Markiewicz MR, Brady MF, Ding EL, et al: Corticosteroids reduce postoperative morbidity after third molar surgery: A systematic review and meta-analysis. *J Oral Maxillofac Surg* 66:1881, 2008.

Kyzas PA: Use of antibiotics in the treatment of mandible fractures: A systematic review. *J Oral Maxillofac Surg* 69:1129, 2011.

Szolnoky G, Szendi-Horvath K, Seres L, et al: Manual lymph drainage efficiently reduces postoperative facial swelling and discomfort after removal of impacted third molars. *Lymphology* 40:138, 2007.

Williams S, Whatman C, Hume PA, et al: Kinesio taping in treatment and prevention of sports injuries: A meta-analysis of the evidence for its effectiveness. *Sports Med* 42:153, 2012.

Chou YH, Li SH, Liao SF, et al: Case report: Manual lymphatic drainage and kinesio taping in the secondary malignant breast cancer-related lymphedema in an arm with arteriovenous (A-V) fistula for hemodialysis. *Am J Hosp Palliat Care*, 2012.

Tsai HJ, Hung HC, Yang JL, et al: Could KT replace the bandage in decongestive lymphatic therapy for breast-cancer-related lymphedema? A pilot study. *Support Care Cancer* 17:1353, 2009.

Spector, L (2008). "Computer-Aided Dental Implant Planning". *Dental Clinics of N Amer* 52 (4): 761–775.

Lindhe, Jan; Lang, Niklaus P; Karring, Thorkild, eds. (2008). *Clinical Periodontology and Implant Dentistry* 5th edition (in English). Oxford, UK: Blackwell Munksgaard. ISBN 9781405160995.

Esposito, M.; Grusovin, M. G.; Polyzos, I. P.; Felice, P.; Worthington, H. V. (2010). "Timing of implant placement after tooth extraction: Immediate, immediate-delayed or delayed implants? A Cochrane systematic review". *European journal of oral implantology* 3 (3): 189–205.

Esposito, M.; Grusovin, M. G.; Maghaireh, H.; Worthington, H. V. (2013). "Interventions for replacing missing teeth: Different times for loading dental implants". *The Cochrane database of systematic reviews* 3 (CD003878): CD003878.

Swarna Chakrapani, K. Sirisha, Anumadi Srilalitha, and Moogala Srinivas, Choice of diagnostic and therapeutic imaging in periodontics and implantology. *J Indian Soc Periodontol*. 2013 Nov-Dec; 17(6): 711–718.

Esposito, M.; Grusovin, M. G.; Chew, Y. S.; Coulthard, P.; Worthington, H. V. (2009). "One-stage versus two-stage implant placement. A Cochrane systematic review of randomised controlled clinical trials". *European journal of oral implantology* 2 (2): 91–99.

Corbella S., Del Fabbro M., Tsesis I., and Taschieri S. Review Article. Computerized Tomography Technique for the Investigation of the Maxillary First Molar Mesiobuccal Root. *International Journal of Dentistry*. Volume 2013, Article ID 614898, 6 pages.

Buser, Daniel; Schenk, Robert K (1994). *Guided bone regeneration in implant dentistry* (in english). Hong Kong: Quintessence Books. ISBN 0867152494.

Markus Schlee, Jan-Friedrich Dehner, Katja Baukloh, Arndt Happe4, Oliver Seitz and Robert Sader, Esthetic outcome of implant-based reconstructions in augmented bone: comparison of autologous and allogeneic bone block grafting with the pink esthetic score (PES), Schlee et al. *Head & Face Medicine* 2014, 10:21.

M. Del Fabbro, S. Taschieri & R. Weinstein Quality of life after microscopic periradicular surgery using two different incision techniques: a randomized clinical study *International Endodontic Journal*, 42, 360–367, 2009.

Lee JM, Warren MP, Mason SM. Effects of ice on nerve conduction velocity. *Physiotherapy*. 1978;64:2–6.

Atieh, M. A.; Atieh, A. H.; Payne, A. G.; Duncan, W. J. (2009). "Immediate loading with single implant crowns: A systematic review and meta-analysis". *The International journal of prosthodontics* 22 (4): 378–387.